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The Welsh Engineers' and Founders' Association
and
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The Early History of Cast Iron

The correspondence which took place in our columns recently on the oldest iron casting shows the keen interest taken in this question. Germany and England are rivals for the honour of introducing what may be termed modern ironfounding. It is not disputed that, perhaps by accident, cast iron was made at a far earlier date, and castings in both ferrous and non-ferrous metal are known from very early times. Some new light has recently been thrown on this question by Professor T. T. Read, of Columbia University, New York, and incidentally this shows how useful is a combination of historical and some technical knowledge. This author says that the idea that iron was not cast before the Middle Ages is erroneous, although supported by Dr. Newton Friend and Mr. T. A. Rickard. There is little doubt, however, that these authors had in mind the events which immediately preceded the industrial revolution and the enormous increase in output which resulted. Professor Read reminds us that iron oxide, widely distributed as an ore, will at a dull red heat and in the presence of carbon, be reduced to iron. The product will not melt below 1,530 deg. C., a temperature above that obtainable in the simple, crude furnaces of the ancients. In time, however, iron in contact with carbon will take up the carbon and in so doing have its melting point lowered; this is the main reason why cast iron melts at about 1,150 deg. C.

It is recorded as a fact that very little cast iron appeared in Europe and Western Asia before the Middle Ages, although bronze had been cast for three thousand years. Professor Read says that the idea that cast iron was not known before that time is due to erroneous German commentators on the Greek historian Pausanias, and adds that Aristotle, writing two centuries before this, was familiar with the melting of iron; it is further suggested that if some statements of the Roman historian Pliny had been correctly understood, it would have been evident that the Romans could, and sometimes did, melt iron. It appears to be known that there are a few pieces of cast iron made in Greek and Roman times. Professor Read's most interesting suggestions, however, relate to the early casting of iron in China, and to this we hope to return in a later issue, for there seems here to be none of the doubt as to whether cast iron was being made, or a bloom of relatively forgeable material.

Shadow Boards

One of the simplest and most efficient methods of tool and spare control known to industry was evolved as a result of laziness, as we learnt in a conversation with Mr. D. Clark, the chief metallurgist of the Vickers Commonwealth Proprietary Company, of Newcastle, New South Wales, who is at present on a business trip to Great Britain. It seems that it has long been the practice in the engine and boiler rooms of sea-going vessels to arrange tools and spare parts along the plating and inner partitions of the ships. The painters on occasion were too lazy to remove the tools and painted round them, leaving their "shadow" on the wall when the tools were removed for use. This system has been seized upon by a number of important manufacturers as the concrete, easily utilisable exemplification of the old adage "A place for everything and everything in its place." The average works manager would inform an inquirer that all loose tools and spare parts were kept in the stores and only obtainable on loan against a requisition signed by a responsible executive, forgetting that when a new engine or machine is delivered there are usually a number of special tools and attachments which never enter the stores. Assuming, however, the storekeeper has impounded such tools and assigned to them a niche in his own department, it is doubtful whether he has in general added to the efficiency of the works. The only object of centralising a stores is to prevent loss, and the consequences resulting therefrom. If however, a system can operate whereby the management still retains full control of tools and spare parts and at the same time reduces the loss of time associated with chit-signing and operatives making journeys to and from the stores, then surely this method is preferable.

The shadow-board system affords all these advantages and has for large concerns been known to save several thousands of pounds a year in reduction of quantity of tools and unnecessary replacements. For its operation, a board is erected against each machine or group of machines; the number and types of tools it requires for its operation and maintenance are decided upon after co-operative consultation, and the outline of each tool is painted upon it. An inspection reveals at a glance the exact situation, especially as to those tools actually in use or missing. To our mind, a stores department should be more like a University, that is, a corporate body which may or may not possess buildings, and the latter may not necessarily be centralised in one area.

XUM

Some Observations on Foundry Planning*

By A. NORMAN HARLEY

Planning as applied to industry is a comparatively recent term. It is a term somewhat overworked, especially by the theorists, and, in common with reorganisation and rationalisation, is frowned upon by the conservative, hailed as a panacea by the hopefully incompetent and recognised by the calmly appraising as cold commercial common sense fitted with a new name.

When skilled moulders were the rule rather than the exception, it was possible to obtain results by handing over a pattern and announcing the number off. Any deficiencies in either pattern or tackle were adequately dealt with by the man.

The foundry trade to-day is a highly competitive business. It carries on that business chiefly by selling goods at a price fixed long before the first article is made or any of the peculiar difficulties of its manufacture encountered. No margin can be included in that price for inaccuracies in any of the estimates of which it is the cumulative result.

The function of foundry planning is to forecast all the normal variables and to foresee the deviations from standard practice which may be necessary to produce a sound casting at a saleable price. A good casting should include the following. It must be:—(1) Made in the material specified; (2) dimensionally accurate; (3) free from defects inherent or apparent; (4) clean, of good appearance; and (5) it must be offered at a competitive price.

Translated into terms of the foundry, this means:—(*a*) Correct metal at the correct temperature; (*b*) suitable plant in which and with which to make moulds and cores; (*c*) adequate pattern equipment; and (*d*) proper cleaning and dressing facilities.

The planning section shares in all those provisions. To do so effectively, the personnel of the section should include:—

(*a*) *Lay-out man*, who from the drawing decides the method of fabrication of the job, *e.g.*, hand mould, plate machine mould, built-up cores, etc.; the pattern equipment required; the probable location of gates, runners, risers, etc.

(*b*) *Draughtsman*, who, in addition to his planning duties mentioned later, will design any special equipment needed, such as moulding boxes or driers.

(*c*) *Plant man*, whose planning duties would chiefly be to ensure that the equipment called for by the lay-out is available. The duties would naturally be undertaken by the plant engineer responsible for the repair and maintenance of all the foundry plant.

(*d*) *Ratefixer*, whose duties, detailed later, would be performed by the shop ratefixer.

(*e*) *Typist*, who would also be responsible for filing drawings, records of variation in shop-production methods, correspondence and instructions relating to pattern alterations and the like.

The planning section as a whole is only called upon to consider direct costs, viz., moulding, coremaking, dressing and possibly the labour ancillary to actual production, such as knocking-out. Figures, such as the cost of molten metal, fixed overheads, scrap margin (and its near relation, profit margin), the cost of any subsequent treatment, *e.g.*, pickling or annealing, should all be available from the general costing system. Special direct charges, like the cost of patterns and special tackle, would be, however, allocated by the planning section.

All the foregoing may seem to suggest setting up a cumbrous organisation to deal with a problem far from new, basically unchanged and hitherto surmounted with reasonable success. But the times change if basic problems do not, and in these days of high-speed repetition production, small inaccuracies in cost estimates cannot be afforded.

To-day even orders for small quantities are expected to be entered at much the same price as for bulk supplies. From this it may be argued that small orders do not warrant intensive planning. Nevertheless, much can be done by attention to vital points. New patterns on which repeat orders are possible should be jointed for mounting on a plate if at all possible.

In general, the operation of a planning section follows a fixed course. On receipt of an inquiry, the drawing goes to the draughtsman, who calculates the weight. The lay-out man then records on a sheet every single operation, excluding pattern work, required to produce the finished casting. This sheet is termed the "operation sheet," and, when finally completed, serves as a master chart of the whole job. After each operation is stated the means for performing that operation. The ratefixer will then estimate the time required for these operations. At the top of the sheet the lay-out man will have specified the pattern equipment required. Drawing and operation sheet now go to the pattern-shop for estimation of the net cost of this equipment. The drawing and operation sheet next pass to the plant man, who notes any special tackle required. If any new tackle is to be provided, he will notify the lay-out man of its probable cost, and endorse it on the operation sheet.

General duties of the section include ensuring that a proof casting is despatched and the report thereon received before releasing any order for bulk production. This entails also watching that a proof is despatched after every revision of the pattern. The section would be responsible for recording office transactions affecting production of the casting, such as despatch of proof, machining report, scrap analyses and periodically checking the weight of individual castings. The clock cards showing the actual times taken on jobs would pass through the section, enabling the operation sheet to be checked against actuality.

The planning section would negotiate with customers, prior to actual quotation, regarding the quality of pattern equipment to be provided, insisting on the provision of proper production equipment when quotations for quantity are expected.

Through the trade Press, the section would be expected to keep in touch with developments in production methods and machinery. The appearance of any new plant likely to assist their own problems would be reported to the management with a view to proper investigation of the claims made.

* An entry for the Short Paper Competition organised by the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen.

"Yoloy" Alloy

"Yoloy" is the trade name which will be applied to the new alloy to be produced by the Youngstown Sheet & Tube Company. It is claimed to have a much greater tensile strength and corrosion-resistance than ordinary steels, and it has already been produced by open-hearth and Bessemer steelmaking processes.

Falkirk Founders' Jubilee Gifts

To mark the celebration of the Silver Jubilee of Their Majesties the King and Queen, the following foundries have donated sums to the Falkirk and District Royal Infirmary:—

	£	s.	d.
Smith & Wellstood, Ltd., Bonnybridge ...	14	3	0
Jones & Campbell, Ltd., Larbert	8	2	7
Grangemouth Iron Co., Ltd., Camelon ...	7	5	7
Callendar-Abbots Foundry Co., Ltd. ...	5	15	5
Dobbie, Forbes & Co., Ltd., Larbert ...	4	19	7
Walker, Hunter & Co., Ltd., Camelon ...	4	12	7
Larbert Art Medal Co., Ltd., Larbert ...	4	10	9
Scottish Enamelling Co., Ltd., Larbert ...	4	10	9
R. & A. Main, Ltd., Camelon	4	4	9
M. Cockburn & Co., Ltd., Grahamston ...	4	3	6
Cruikshank & Co., Ltd., Denny	3	15	0
Forth & Clyde & Sunnyside Iron Co., Ltd., Camelon	3	2	9
Robert Taylor & Co., Larbert	2	18	2
Burnbank Foundry Co., Ltd., Falkirk ...	2	11	2
Carmuirs Iron Co., Ltd., Camelon ...	2	9	4
Dorrator Iron Co., Ltd., Camelon ...	2	9	2
Scottish Central Iron Co., Ltd., Camelon	2	2	5
Summerford Iron Co., Ltd., Camelon ...	1	18	11
Grahamston Iron Co., Ltd., Falkirk ...	1	18	6
George Paul & Co., Ltd., Denny ...	1	17	5
Camelon Iron Co., Ltd., Denny	1	16	4
Comelybank Foundry Co., Ltd., Denny ...		16	7
Abbotshaugh Engineering Co., Ltd. ...		11	4
Fred. Braby & Co., Ltd., Falkirk		5	6
Total ...	91	1	1

The Lindberg Regulator

In pursuance of their policy of making available to British users the latest developments in heat treatment technique in other countries, Messrs. Birmingham Electric Furnaces, Limited, have acquired the sole rights in the British Isles for the Lindberg regulator. This instrument has been supplied previously only by the Lindberg Steel Treating Company of Chicago, U.S.A., but will now be manufactured and sold in England under the name "Birlec-Lindberg" Controller. The primary function of this instrument is the provision of a simple, accurate means for regulating the heat input to furnaces heated by electricity, gas or oil. Its use, therefore, permits a high initial rate of heating to be obtained while allowing power to be reduced to any desired extent in order to minimise temperature fluctuations during "soaking" and when working at low temperature. The Birlec-Lindberg Controller is available in a number of types designed to meet every requirement and, by its use, an improved degree of control is obtained such as could be otherwise provided only by comparatively complicated and expensively electrical equipment.

Electrode for Restoring Faces of Worn Tools

An arc-welding electrode, designed for restoring worn cutting edges on tools of all kinds and which is said to permit savings of 20 to 25 per cent. in tool cost is announced by the Lincoln Electric Company, Cleveland. Lathe tools, bits, cutters, drills, cutting and forming dies and similar equipment which have become worn in service can, it is claimed, be given a new and harder cutting edge than has heretofore been attainable; also unlimited numbers of refacings are said to be practical. This "Toolweld" electrode provides a deposit the equivalent in hardness of high-speed tool steel, and having an advantage of retaining its hardness under relatively high temperatures, up to approximately 1,000 deg. Fah. In a recent test a tool faced with "Toolweld" turned 14 motor-generator shafts to a depth of $\frac{3}{8}$ in., the length of cut being 15 in. Using ordinary tool steel, 12-in. cuts $\frac{1}{16}$ in. deep were made on six shafts. In both cases the operating speed was 117 r.p.m. Inspection of the two tools at the end of the test showed that the one faced with "Toolweld" had a square, sharp edge, whereas the cutting edge of the tool-steel tool had become rounded off.—"The Iron Age."

RECENT ORDERS secured by Messrs. Tangyes, Limited, Cornwall Works, Birmingham, include one for a 3,250-ton hydraulic press for constructional steel work.

Patternmaking*

By ALEXANDER MARSHALL

Directing Principles

The patternmaker is called upon to give his decision upon several factors, as, for instance, the drawings upon which proper interpretation is necessary, as it must be remembered that the patternmaker is the creator of a concrete form from the sketch, blue-print, or in some cases verbal instructions—the most treacherous of all.

It is essential to have first-class drawings. Prints taken direct from a pencil drawing are never distinct. When a workman has to consider whether a line is intended as a full line or as a dotted line, or if measurements are indistinct, he very often makes wrong decisions, with

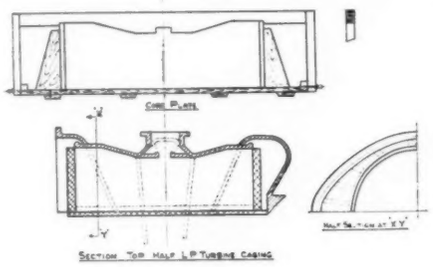


FIG. 1.

the result that the casting is wrong and valuable time is wasted, tempers frayed and the usual blame-pushing ensues.

Material

This is of vital importance; the selection of the breaking out of timber should be planned as far as possible to avoid the appearance of a super-knot on a working edge. The reward of such neglect is time and energy wasted. Next follows construction, that is, the proper arrangement of the material. Some of the questions to be dealt with here are: "Which is the best way to run the grain to prevent warping? and Should the pattern be "solid," "built up with segments," "boxed up," or "framed" and panelled"? Efficient operations by machinery and making full use of this medium is another important consideration.

Contraction

This, of course, differs with the various metals, but the use of a standard contraction rule is not always the correct procedure. Contraction may differ with different types of castings, and a modification of the rule allowance must be made where necessary, and from observation the question of camber can only be mastered by experience, and many mistakes will be made until one ultimately secures uniformity of design on particular types.

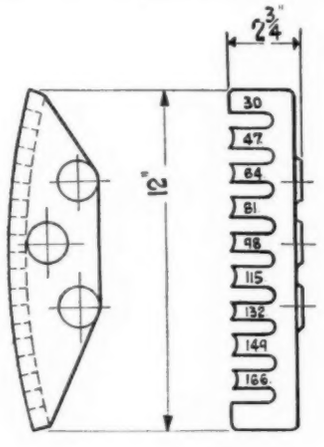
Foundry Sense

This, in the author's opinion, can only be obtained by continual visits to the foundry, and at convenient times entering into discussion with the moulder on the job, and although the moulder may be severe in his criticism, the policy is to listen and consider. The patternmaker is developing his foundry sense. The patternmaker with a good knowledge of the foundry can, after having drawn his job down to the lay-out board, visualise the proper procedure necessary in the construction of his pattern. Half the battle is over then. There are plenty of opportunities for the moulder to develop his pattern sense, as it very often happens, when he is called into this department to discuss the moulding of any particular job, he merely scans over the blue-print, makes a statement on the method of moulding, and, of course, when the pattern is nearing completion, realises his mistake, which may mean the cutting and destroying of the pattern.

Fig. 1 shows a sketch of the top half of an L.P. turbine casing. The construction of a job of this kind involves much careful forethought.

Method of Construction.—The material is selected and broken out for the flange and print. This means the drawing-off and half-checking of the frame to take the necessary profile of the print and flange. Prints are fixed on the flange and placed on battens fixed on a particular part of shop selected for the building of such a job. The battens are levelled off. The barrel is built up of staves fixed on "bridges" and carried straight through; the tapered portion is made up of $\frac{3}{8}$-in. thickness sections, and the bead or flange is fixed on, after which the prints are boxed up and fixed on separately. The end sections are so constructed as to leave their own cone. There is a segmental ring built to the shape at section through "XY" for both ends, and extending in length or depths to full extent of flat section. From this the thickness sections are fixed and the thicknesses of metal, say $\frac{1}{2}$ in. by 2 in. broad, are spaced off at about 9 in. apart. Sections are fixed by means of pocket screws at convenient parts of the job, so that they can be easily removed in the foundry. The centre section is constructed in a similar manner, built-up ring for the centre flat thickness section at each side. The main branch ring of segments with the flange is to be drawn in. The barrel core is swept up, the bottom plate framed the shape of the print and of the same thickness, and the remainder is swept up. The coreboxes or plates are made for the branches, stools, bearings, etc., attached to the job.

Fig. 2 shows a sketch of a small lever-control bracket. The slots have to be cored out and the numbers cast on in raised figures, which to some extent would lock the pattern in the sand. The



CONTROL LEVER BRACKET.

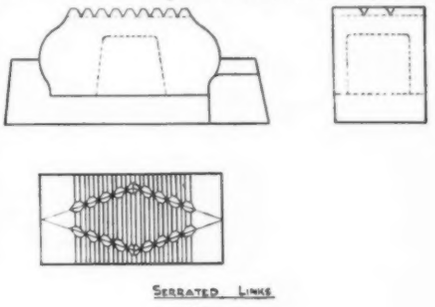
FIG. 2.

pattern was blocked out, and, with the exception of the numbers, the job was encased in the core-box.

Fig. 3 is a sketch of a small chain link, made by means of six patterns on plate, with the serrations cast in. The patterns were made, as is shown, with an overhanging print plate withdrawn and the core dropped in. This job is made on the multiple-moulding principle—a total of 48 castings in the one tree.

Medium-Sized Patterns

Wherever possible, patterns that are of a medium size should be made in halves at the joint of the mould. This enables the moulder to place each half on a flat plate and either "jolt" them or use the Sandslinger effectively. The object, of course, is to have as much of a mould as possible in drag. Deep projections on the top half of patterns might be dowelled in position. This will assist the moulder in the drawing of the pattern. If a core can be avoided, it is always advisable to do so, thereby reducing the cost of patternmaking. The baseplate shown in Fig. 4 is a very good type of casting to consider for avoiding cores. Plenty of taper should be allowed in the sides of the pattern; the moulder can then lift out the inside of the baseplate with the top part. Fig. 4 shows how the baseplate should be made; it will



SERRATED LINKS

FIG. 3.

(Reduced to third full size.)

be noticed that the sides of the box section run from top to bottom of the pattern. By using this method the bottom plate will not swell, and will result in the moulder having a good "draw." If the plate be carried the full width and the sides built on, swelling will readily take place. The moulder would get a bad "draw," and most probably a spoilt mould. If the pattern be a large engine bedplate of similar section and cored out, the construction is quite a different proposition, but here again the sides should be run from top to bottom. The joints of the cleating should be left open to prevent twisting due to tight joints.

Large circular pattern that are to be moulded on-end require careful building-up in order that they may be successfully used in the foundry. For instance, with a circular pattern, about 4 ft. in dia. by 6 ft. long, the interior frame should be built up of two layers of segments, each layer not less than 1 in. thick; this will give a 2-in. frame and a good screwing surface for staves. A piece of timber about $1\frac{1}{2}$ in. thick, run diametrically across each frame, will enable the vertical struts to be run from the top to the bottom of the job, and screwed to each frame, thus preventing movement in the centre. The struts also provide support for the bottom plate and prevent it from being damaged. If the staves are 3 in. by $1\frac{1}{2}$ in., the curvature of the plate over this width is practically nil. Rebates can be cut in each with the dimension saw about $\frac{3}{8}$ in. deep, and the width of the top and bottom plates. The rebate supports the top and bottom plates, especially when "drawing" the pattern. A metal-lifting plate, screwed on the bottom, will enable the pull on the pattern to be applied at the bottom of the mould.

Fig. 5 shows sketches of sweep boards, together with a section of complete cylinder-liner mould. The horizontal bar is made parallel, which enables the moulder or patternmaker, when fixing the sweep to the spindle, to place it level on the top side and assists in easy adjustment of the sweep ring-board and size-stick supplied. The core and mould are swept in one operation.

A double-faced pattern plate is shown in Fig. 6. This plate has been adopted for use in moulding machines which squeeze the top and bottom moulds simultaneously. Fig. 6 shows the equipment and several operations in the manu-

D

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. D. Sharp presiding.

facture of a double-faced pattern plate, and Fig. 7 shows another type of mass-production plate used in machine moulding.

Painting of Patterns

The painting of patterns is a part of the process of patternmaking that is very often given little consideration, but, unless it is carried out properly, it is far better to leave the pattern "white." If cheap-quality or badly-mixed varnish is used, a bad draw will result. There are various makers of first-class pattern varnish.

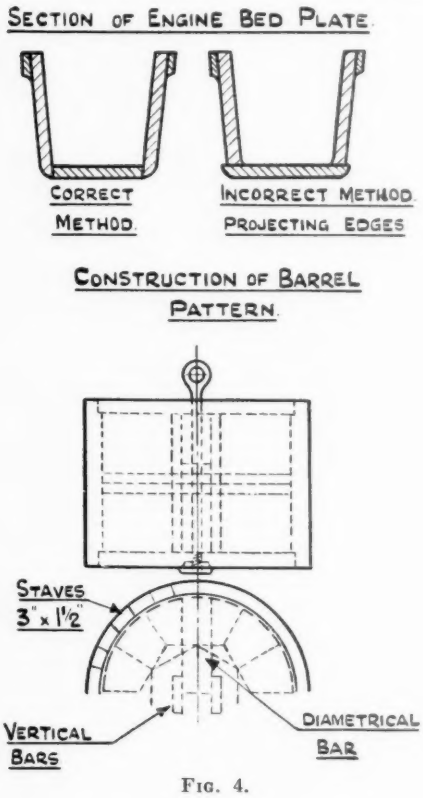


Fig. 4.

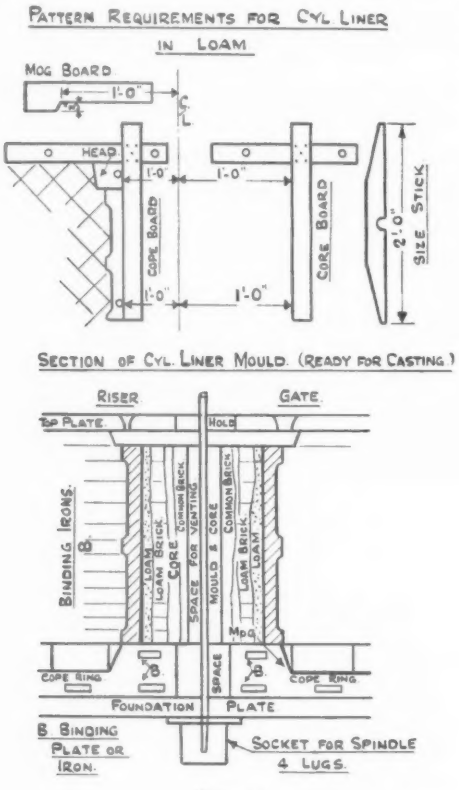


Fig. 5.

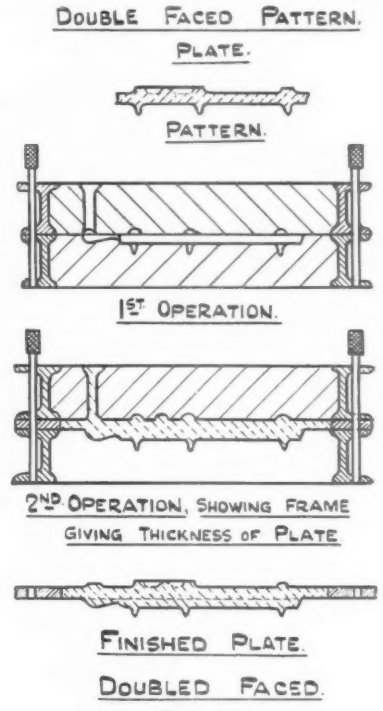


Fig. 6.

and most firms have a colour scheme of their own. For instance, it is customary to paint unmachined parts yellow, prints black, and machine parts red. This shows the moulder where tooling is required, and thus he can make arrangements to keep those parts as clean as possible. The author advocates bright colours on patterns, as it is noticeable that bright-coloured patterns suffer less damage than those painted with dull colours.

Pattern Storage

The question of pattern storage is a source of worry to everyone connected with the management of a patternshop. When patterns come back from the foundry, a place must be found for them. Racks of various types may be used; one commonly used is sparred off in sections, allowing the air to pass through. To keep a record of the movements of a pattern is the work of the patternshop office, and various systems are used to achieve this end. One system is for the drawing office to give each new pattern a number; this number is put on the drawing that goes to the shop, and thus the pattern is on record before being made. A card giving the number of job, number of coreboxes, number of loose pieces, etc., grade of metal, and date when sent, accompanies patterns and coreboxes stamped with this number to the foundry. When the castings are completed, the card is returned.

Costing of Patterns

The cost office and patternshop very rarely agree as to the costing of patterns. In a patternshop a large amount of the work is done by hand, whereas in a machine shop the whole of the work is done by machines. The speed of a machine can be ascertained and a fairly accurate estimate made. But when one considers the various parts of a pattern, the necessary coreboxes and the finish, and the fact that the bulk of the work must be done by hand, it can easily be seen how difficult it is to obtain an accurate cost. Experience gives one a good idea of the time taken on certain classes of work, but even then it is often only a rough estimate, as a few lines or altered dimensions may alter the entire construction of the pattern. In working out the cost of material the class of timber should be carefully watched; for instance, white or third-quality pine should be used for all interior frames and the outsides of coreboxes. If these points are noted a great saving can be effected on timber alone. It can, therefore, be seen how difficult it is for a practical man to estimate the cost of a pattern, and it must be very much more difficult for a man who has no practical experience of the craft to do the estimating.

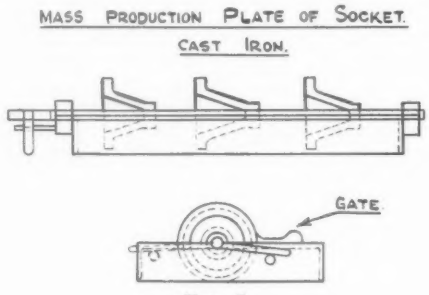


Fig. 7.

Machinery

In setting out the equipment of a patternshop the number and types of machines may be governed by the number of men employed, and class of work carried on. A cross-cutting saw installed in the timber store can prove a valuable machine. The machine stands immediately behind a long table, on which the timber to be cut is placed, and the saw is drawn forward by hand through the timber. The saw moves forward with very little effort on the part of the operator, and the cut is made perfectly square both ways. The next operation in the sequence is to reduce the timber to the desired width on the saw bench. This machine, probably the most common of all wood-working machines, carries a saw up to 24 in. dia. and has a table with rising and falling movements. Angular ripping up to 45 deg. can be done by canting the fence, which is arranged so that it can be quickly moved across the table to the required distance. The fence can also be turned over, leaving table clear. The saw is completely guarded below. Another type of saw bench is the universal or tilting spindle saw, which is very useful, and can be made to tilt at various angles, being used for shallow rips, cross-cutting, grooving, and being particularly useful for half lapping.

The next stage—the planing and thicknessing of the timber—is done by the combination planer. Passing the timber over the top table surfaces and straightens the material, and then thicknessing is carried out by setting the machine to the thickness required and passing the timber underneath. It is only a matter of a few minutes, and the entire operation is carried out on a 15 in. by 11 in. board, which comes away from the machine perfectly true and straight, reduced to its exact thickness alone its entire length. In addition, the fence can be canted up to 45 deg. for narrow bevel planing. A wide range of working can be carried through, such as champering, stop champering, tonguing and grooving. The cutter block is of the circular type, and knives are quickly adjusted. A good deal of hand-planing by the patternmaker could be dispensed with if a small surfacing machine were close at hand. The machines can be fitted at the end of the bench. As far as accuracy and smoothness of cut are concerned, they are every bit as efficient as the bigger machines. They are electrically-driven, which enables them to be placed in the most convenient position in relation to the benches.

A modern self-contained electric-driven band saw is an essential machine in an up-to-date

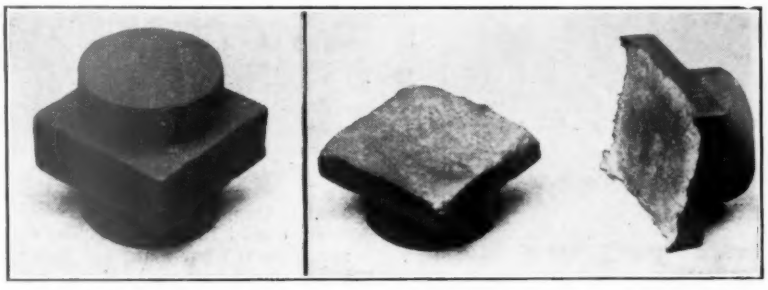
(*Concluded on page* 350.)

Some Factors which Influence Soundness in Non-Ferrous Castings*

By ARTHUR LOGAN

Historical

It would be difficult, if not impossible, to assign a date to the period when founding was first consciously practised. If all the facts regarding the practice and development (the evolution, if preferred) of founding, from the dawn of history down to the present, could be known, the story would reveal man's triumph over difficulties, his adaptability and resourcefulness, his improvisations and gradual development. The discovery and use of copper and bronze, whilst probably quite accidental, must have resulted in a big step forward in the march of progress and civilisation.



FIGS. 1 AND 2 SHOW A CASTING, WHICH, THOUGH APPARENTLY SOUND, SPLIT, DUE TO OXIDE FILM, ON MACHINING.

The very earliest forms of metal working would undoubtedly be the use of the metal in the wrought form, such material being either native copper or copper or bronze produced by accidental reduction of ore in the ashes of a charcoal fire. One can picture the discovery of lumps of strange heavy "stone" among the ashes of the fire. The stone-conscious neolithic man would examine this strange mass with his expert eye and decide that here was a special piece of stone eminently suitable for the manufacture of a new axe-head. One can imagine with what further delight the discovery would be made that this strange new material possessed peculiar properties which rendered it capable of being fashioned into shape by beating and hammering. As knowledge of the new material was disseminated, it would be found that it could be much more easily worked and wrought when heated, and from there it would only be a step to the further discovery that, if heated sufficiently, it would become plastic and eventually liquid enough to run of its own accord and fill up a rough impression in a rock or piece of baked clay. Thus, the rudimentary idea of casting would be evolved. The discovery that metal could be melted or made out of rocks, in whatever way it happened, was surely the most momentous step in man's conflict with nature. The whole of civilisation hinges upon this point. There is no reason to suppose that the early founders knew of the existence of the metal tin. Tin does not exist in nature as native tin. It is logical to assume that the earliest bronzes were due to accidental mixture of the ores of copper and tin. The early metallurgist in certain districts would learn to associate the production of a harder product with the use of the ore containing a heavy brown or black mineral, which is now known as Cassiterite or tin oxide. In time, possibly, curiosity would cause him to smelt some of this material by itself to see what kind of "copper" he would obtain; and no doubt he would be very surprised to find the resultant metal not the super-hard reddish copper metal he was expecting, but a new soft white material, or, in other words, tin.

According to Richard, in his Paper on "The Early Use of Metals," the copper deposits of Sinai, from which the ancient Egyptians obtained their supplies of copper, do not contain tin, so that the discovery of bronze must have been made elsewhere.

The earliest copper daggers found in Cyprus are of nearly pure copper, so pure that the material is probably native copper. The later ones contain tin in growing proportion up to 13 per cent., indicating the beginning of purposeful bronze-making. Trade between Cyprus and Egypt was well established, so probably the knowledge came to Egypt from there.

The first requirement of primitive man was to provide himself with implements and weapons. Modern research has shown that the addition of a small amount of tin (up to 3 per cent.) to copper increases the hardness when cold-forged, and beyond this amount gives rise to brittleness unless annealing during forging is resorted to. About 8 per cent. tin would result in an alloy too brittle to forge satisfactorily. Whether a few highly-skilled technicians were definitely aware of this fact, it is difficult to say, but it is certain, however, that, as the amount of metal working progressed, the knowledge that tin definitely increased the fluidity of the molten metal was known and applied. Here is probably the chief advantage of converting the copper into a bronze. Copper by itself is very difficult to cast satisfactorily. Even in these enlightened times, the satisfactory production of a good casting in pure copper is almost impossible, due to the absorption of gas and the release of this on solidifying. The presence of tin checks this excessive gas absorption, and tends to give a sharp impression, the net shrinkage on cooling being sufficient to enable the casting to be separated from the mould. Here, then, is the main reason why bronze became so important, for in the classic period, statuary and art castings were produced in great quantity.

In a similar empirical manner to the production of bronze, brass was also known and produced about 300 B.C.—at least 1,800 years before the metal zinc itself was isolated, as it was, by Erasmus Ebener, in A.D. 1509. However, leaving this fascinating subject of the early uses and manufacture of non-ferrous alloys, let us look at the alloys in use at the present time.

Present-Day Practice

The ordinary brasses and bronzes—alloys of copper and tin and copper and zinc—like the poor, are always with us. Many articles are made to-day of similar composition to alloys made 5,000 or more years ago, and it is a certainty that many of the common foundry troubles now being experienced were suffered by those very early pioneer founders. In the copper-tin series, alloys containing more than 25 per cent. tin are useless—being too weak and brittle. There is a rough sub-division which is usually made into gunmetal containing from 8 to 15 per cent. tin, and Bell metal containing from 14 to 25 per cent. tin. Gunmetal, as its name implies, was the material used for the manufacture of guns before the invention or discovery of iron or steel. Practically all guns, wherever manufactured, consisted of a straight copper-tin alloy, usually ranging from 92 per cent. copper with 8 per cent. tin to 89 per cent. copper and 11 per cent. tin. Even in later mediæval times, apparently it was known that the range 8 to 11 per cent. tin gave the best combination of strength, elasticity and shock resistance.

Admiralty Gunmetal

The material known as Admiralty gunmetal to-day has 2 per cent. zinc incorporated, giving a composition of 88 copper, 10 tin and 2 per cent. zinc. The zinc is added mainly as a deoxidant and to give increased fluidity. This alloy is of universal application, and is used extensively in all branches of engineering. The present Admiralty specification calls for 16 tons per sq. in. tensile and 8 per cent. elongation, and under good conditions these figures are easily attained.

A few years ago, the Admiralty specification asked for 14 tons per sq. in. and 7 per cent. elongation; and it is quite conceivable that at some not-far-distant future date this specification may again be further increased. The strange thing is that the alloy remains exactly as it has always been, and the material going into the casting is still 88:10:2; and the increased physical properties are met by improved foundry technique and by knowledge of test-bar production. It is necessary to qualify this by the assurance that it is not suggested that increased test figures are obtained by any doubtful means or test-bar manipulation, but rather that the casting requires to be poured and run in such a way that the production of a sound and strong test-bar receives prior consideration. The conditions which produce the best bar may not necessarily produce the best casting to which that particular bar is attached. As an aid in the production of fluid metal, and sound, clean-run castings, phosphor copper is often used as a deoxidant, and definitely assists in this direction and is beneficial, providing not more is added than will leave 0.05 per cent. P in the

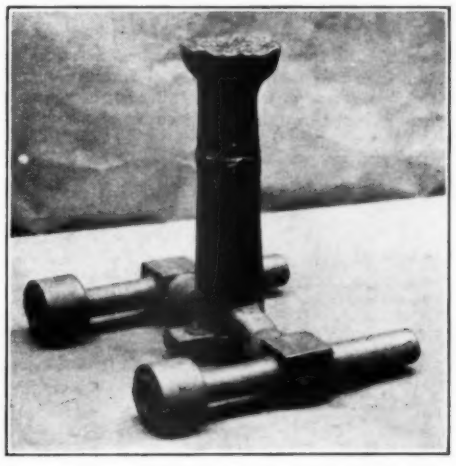


FIG. 3.—TYPE OF CASTING USED IN DENSITY DETERMINATION EXPERIMENTS.

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. H. Hurst presiding.

finished alloy. On the other hand, phosphorus is definitely added in quantity to straight copper-tin alloys to increase the hardness and to improve the wearing properties of bushes and similar parts. Usually, the tin is fairly high in this class of alloy, being about 11 to 12 per cent. with about 0.3 to 0.5 per cent. phosphorus. In some cases the tin is as high as 14 to 15 per cent.

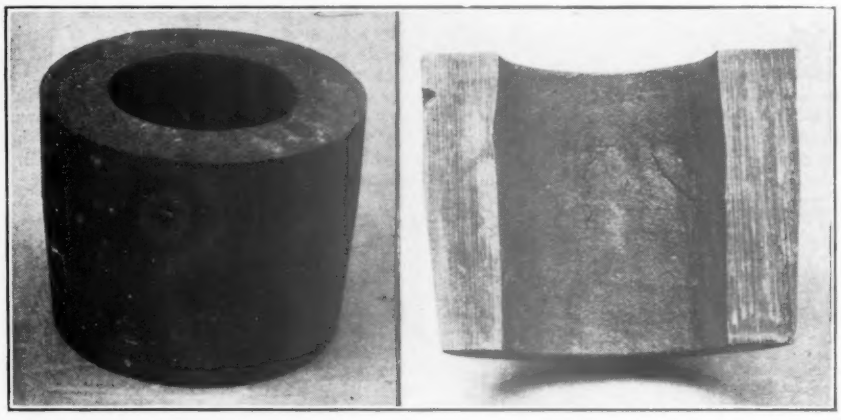
Too Many Specifications

Apart from two or three definite high-quality standard bronze alloys of these types, however, there are dozens and dozens of compositions resulting from the combination of the four metals, copper, tin, lead and zinc. Practically every public body, and every firm which buys non-ferrous castings, issues its own specifications or has its own particular idea as to what compositions it requires for its own particular job. Many of these compositions differ from each other by variations of only 1 per cent. or less, and it is obvious that in many cases there is neither rhyme nor reason for the variations asked for by different specifying bodies for the same class of casting. This state of affairs makes the life of the brassfounder very trying. In a large foundry where many different compositions are required, and are going through simultaneously, it requires very good organisation and much care to ensure accuracy of individual mixtures, and the greater the number of compositions going through, the greater the work involved, not only in the initial issuing of materials, but in the care of returns and foundry scrap, etc.

Fig. 6 shows a Defective Valve Bridge.

Extra care and attention mean increased cost, and as a great amount of the extra work involved is unnecessary, or would be so if the number of mixtures in use were restricted, there is here indicated a real need for further standardisation. Many firms on the highest class of work, especially where already doing Admiralty work, adhere to the Admiralty standard gunmetal, allowing themselves perhaps a little more latitude in the lead content. The B.S.I. have a gunmetal specification which is very little lower than the Admiralty standard. (There is a little more latitude as regards what the Admiralty are pleased to call impurities, otherwise the same physical properties are required.)

It is obvious that this does not completely meet the needs of present-day engineering practice where low costs and economical production are the prime factors; and a move is now being made to have a range of additional bronzes standardised. The composition of the already existing B.S.I. gunmetal is 88/10/2. The suggested range would have decreasing amounts of tin and copper and increasing amounts of lead and zinc, the physical properties being graded accordingly. An additional range of leaded phosphor bronzes is likewise under consideration, where increasing amounts of lead would be specified. The ultimate adoption of the proposed new alloys and the eventual use of these alloys in industry, will go a long way to simplifying the work of the non-ferrous founder, and will provide a more uniform product with definite physical properties at a cheaper cost.



Figs. 4 and 5.—Showing the Influence of Methods of Running upon Soundness of Casting.

Causes of Unsoundness

Turning now to a direct consideration of some of the causes of unsoundness, it would be a fairly safe generalisation to state that there is no such thing as a perfect casting—that all castings, whatever the material, suffer from defects of one kind or another. Sometimes these defects are obvious, often they are not so obvious. The majority of defects are usually internal and may not be revealed by machining. They may not even be revealed by a pressure test, in which case the casting is said to be a "good" casting, and goes into service. It may, in actual service, prove perfectly good enough; and it may only be years later, at the close of its useful life, when the casting lies in pieces on the scrap heap, that the mysteries of its "guts" are exposed. In this connection, a few minutes spent examining sections and fractures of broken scrap can be very illuminating.

Year by year the demands of engineering become more exacting, and new alloys are constantly being evolved to meet the increased demands, but it is necessary for the manufacturers of even the ordinary common alloys to keep a very careful eye upon their products and strive to increase the soundness and reliability of all castings. Before one can say that a particular casting is defective, one should be able first of all to define a perfectly sound casting. Primarily it should be a perfect replica of the original drawing or pattern from which it is made, as regards shape and size. The material of which it is made, at atmospheric temperature and pressure, should occupy a certain definite volume; that is to say, the specific gravity should be the maximum for the particular alloy used. This latter point is probably the most vital factor of all as regards soundness of castings. If the specific gravity of a number of cast pieces of the same alloy be determined, it will be found that the pieces vary. Portions even of the same casting will be found to differ.

Percentage Waste

In general, one could state that the perfectly sound casting does not exist, *i.e.*, that the total specific gravity of a casting is hardly ever the maximum possible for the alloy, nor is it the same in all parts of the casting. This discrepancy is due to the presence of looseness or cavities constituting unsoundness ranging from an overall porosity where the size of the cavity is microscopic and the numbers enormous, to the isolated holes or porous patches which are sometimes encountered. The cavities may be filled with extraneous material, such as slag, oxide inclusions, sand or dirt from the mould, or they may be gas filled, or even the opposite—partial vacua. One is tempted to ask what is the average percentage of faulty castings produced? This, of course, is a matter which varies considerably from foundry to foundry, according to the class of work made, the purpose for which the castings are required, the alloys they are cast from, and the skill and degree of scientific knowledge or control exercised. Taking a specific case—the production of fittings such as cocks and valves, etc., in Admiralty gunmetal, anything in size up to about ½ cwt.—the percentage of wasters from all causes in personal experience does not exceed 1.5 per cent. The normal figure is round about 1 per cent., and under this figure can be considered to be very good practice. There are other classes of work with other alloys where a figure of 5 per cent. would not be considered excessive.

It is often very instructive to analyse the causes of faulty castings. Here, again, it is difficult to generalise, as the purpose for which the casting is made plays such a big part. Parts which require to be machined will naturally be rejected if the machining reveals any unsightly marking due to occluded dirt or sand, or if sufficient machining allowance is not available through misplacement or movement of cores, etc. On the other hand, a casting which is subjected to a pressure test has this additional hazard following after the machining, so that the chances of failure are very much increased. Actually, as might be expected, the majority of wasters are discovered on water test—the proportion of "porous" castings to castings defective by reason of what may be termed purely moulding faults or difficulties being somewhere in the region of 3 to 1. It would take too long to enumerate in detail all the causes of defective castings, even if such were completely known, but the following are some of the most important. To be logical, one should start at the designing end, but as this involves a consideration of basic principles, it will be left

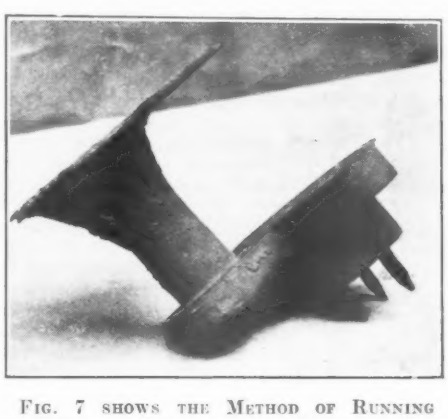


Fig. 7 shows the Method of Running Used to Eradicate the Defect shown in Fig. 6.

until later. Purely moulding defects are usually fairly obvious. Such things as leaving out small cores, incorrectly setting a core, or a movement of a core when casting due to flotation, part of the mould breaking or washing away when pouring, etc., are elementary and easily accounted for, and can prove very annoying and wasteful in practice. Such things as warped patterns or coreboxes can result in much waste time, and even scrapped castings when the castings are small and/or the machining allowance very fine.

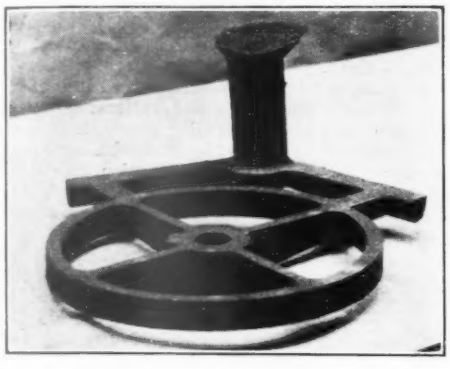


Fig. 8.—The Small Boss on the Centre Hub caused Difficulty with this Casting.

Defects from Sand

The actual sand used has a vital influence on the soundness or otherwise of the resulting casting, particularly when "batch" or mass production is in operation; and this matter is receiving more and more attention nowadays. Sand control alone can be the means of directly lowering the percentage of faulty castings turned out. There is a tremendous number of troubles which can occur due to moulding, and, when once the casting has been removed from the mould, the cause is anything but obvious, and in some cases becomes almost impossible to trace. The manner in which the moulding of a particular casting is tackled—the method of running and gating are vital points. The method of moulding is usually settled at the pattern-making stage, after collaboration between the patternshop and foundry, and the same basic principles which should be kept in mind when designing are applied. Even given a perfect pattern, however, one is still dependent upon the individual skill and care of the actual moulder to a considerable degree. Granted, however, the possibility of a mould which is capable of giving a correctly-dimensioned casting, there are still a large number of snags which can prevent the attainment of that ideal—the perfect casting.

Melting and Mould Conditions

The melting of the particular alloy will require to be carried out with care. All non-ferrous alloys are very susceptible to oxidation at high temperatures, and tend to absorb oxygen and other gases during melting. This can cause trouble through the separation of oxide films during solidification, and evolution of gas can occur prior to, and during, solidification. In addition to gas absorption during melting and its liberation during solidification, there is also the large evolution of gas from the material forming the walls of the mould to contend with. In green-sand work, too high a moisture content of the sand, or the excessive use of the swab in finishing a mould, are ever-present danger potentialities, and have to be continually controlled. A dry-sand mould *should be a dry-sand mould*, yet how often "inquests" reveal that the risk was taken. These practical moulding difficulties are the merest foundry platitudes, but long experience has shown that they can never be entirely eliminated. Every faulty casting analysis over a period will show its percentage of wasters from such causes, and it depends entirely upon the degree of supervision as to how low this percentage can be kept.

There is also the possibility of clumsy pouring, or a wrongly-shaped pouring basin creating turbulence which can carry free air down with the stream of metal into the mould. This is a much greater hazard with non-ferrous alloys than with cast iron. An interrupted, or broken pour, too, is almost invariably fatal. Where there are a number of small castings in a box, careful arrangement of the running is desirable to avoid what amounts in effect to a broken pour.

An Unexpected Defect

Sometimes some of the castings near the runner may almost fill up; then a rush of metal occurs to others farther away, with the result that the first castings are partially drained. When they finally fill up again, the additional metal may not unite perfectly to the original, and curious effects are sometimes observed. One such casting, which looked perfect when removed from the mould, came in two halves when machining commenced, and was found to be separated by a complete oxide film across the section. This is illustrated in Figs. 1 and 2.

Fluidity

Fluidity, or, more properly, the viscosity, of the liquid metal, and surface tension effects vary considerably from alloy to alloy. If the metal be sufficiently fluid, for instance, any entrapped air or liberated gas will have a much better chance to escape. This brings in a consideration of the casting temperature, as the fluidity and viscosity are dependent to some extent upon the degree of superheat given to the metal. In general, every alloy has its own range of safe pouring temperature. This is often quite considerable, as in the case of Admiralty gunmetal, where the range for normal foundry working is from 1,100 to 1,220 deg. C. This does not imply that any casting can be poured in this range and good results secured. Each casting definitely has its own correct casting temperature, which will depend upon the size, section and mass of the object to be cast.

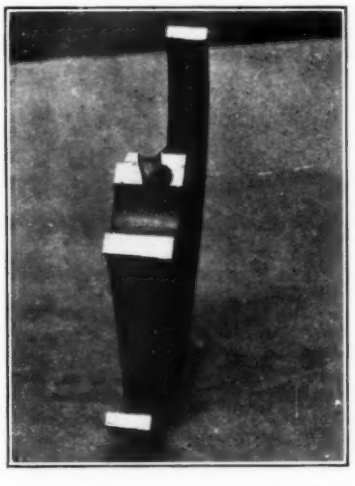


Fig. 9 shows the Nature of the Defect noted in Fig. 8.

In many cases, especially where there are big differences of section, it is obvious that the particular casting temperature chosen must be a compromise; and this is where foundry skill and experience count, for the running and feeding must be so arranged that the casting is completely filled with metal that is hot and fluid enough to run the thin sections perfectly, yet not to have excessive superheat in the thicker sections. The feeding of thick sections must also be arranged to cater for the liquid shrinkage which occurs on a falling temperature before solidification. For this reason, it is necessary to arrange that the solidification takes place as far as possible progressively from outlying sections in towards feeding points.

Solid Cooling

Liquid metal, whilst cooling in a mould, undergoes three definite phases. There is the period immediately after the mould is filled, when, if only for a second or two, the mould space is filled with a rapidly-cooling liquid. All liquids decrease in volume whilst cooling, and liquid metal is no exception. Little definite data are available, however, of the extent of this liquid shrinkage. In any case, it is to be presumed that the metal still being liquid, loss of volume is made good by further inflow of metal from the feeding head or gate. If solidification of the feeding head or gate take place before the casting, then a "pipe" will be found extending into the casting when the gate is broken off.

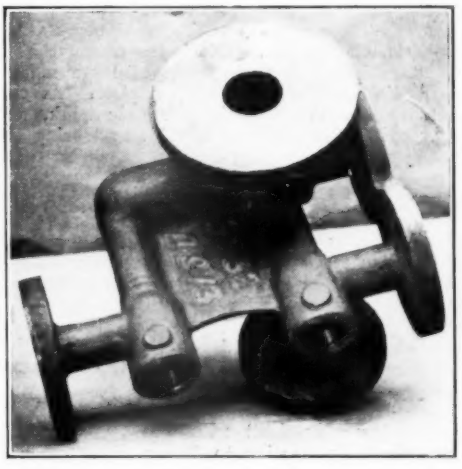


Fig. 10 shows a Casting, liable to Defects through Excess Ribbing.

The second phase is reached when the liquid metal commences to solidify. All substances which crystallise on freezing undergo a volume change at this point. Metals and alloys usually contract considerably, although there are certain well-known exceptions, such as bismuth and its alloys. Very little is known of this phase, but it is of paramount importance from the foundry point of view. It should be remembered that crystallisation always proceeds at a right-angle from the cooling surface of the mould. When the mould is filled with molten metal, the cold sand forming the mould walls immediately commences to abstract heat from the liquid in contact with it. It will be obvious that the higher the superheat of the metal the greater the amount of heat there will be to be imparted to, and dissipated by, the mould. As sand is a very poor conductor, the rate of cooling to the atmosphere is slow, so the effect of greater casting temperature is to give, in effect, slower cooling. Bronze has an extended freezing range, and as the outer layer of metal is cooled by contact with the mould wall, the temperature of solidification is reached and dendrites proceed to grow inwards into the cooling metal. The primary dendrites form a solid net work which gradually thickens and extends inwards. As the temperature falls, secondary dendrites branch out, and from these other dendrites proceed to fill in the spaces. As the solidification is proceeding, the volume is decreasing, as the solid dendrites occupy less space than the molten liquid from which they are formed. As long as any liquid remains at the centre of the section it will flow through the spaces between the branches of the dendritic "trees," so to speak, though with increasing

difficulty, and make good this solidification contraction. It is essential, therefore, to ensure that each section is fed with still liquid metal, to make good this demand. This is the reason that, as far as possible, progressive solidification from the most remote part of the casting back to the runner or feeding head should be arranged for.

The third phase is the decrease in size of the solid casting as it cools down to atmospheric temperature. This does not take place uniformly, but is greatest at temperatures near the freezing point, decreasing as it nears atmospheric temperature. This is the reason that it is essential to free the cores of large moulds immediately solidification is complete. At this temperature the alloy is extremely weak, and any restriction at all will result in tearing the casting apart.

Controllable Variables

The variables which the foundryman has at his disposal after the design of the casting is fixed, are the way up he decides to mould it, the arrangement, size and number of runners and feeding heads, and the casting temperature. The casting temperature normally fixes the rate of cooling, but to a slight degree the rate of cooling may be varied by means of chills to compensate for unequal section.

The crystallising habits and structure of the particular alloy dealt with also require to be considered in relation to design, in order that the casting be given every chance to be sound and free from internal stress (and not, as many foundrymen believe when they receive a new pattern of strange and weird shape, to be expressly designed to do the very opposite). Extreme changes of section are always very difficult to obtain completely sound. The ultimate criterion of a casting is the actual structure of the alloy forming it, and this depends upon all the factors which operate to produce the casting itself, right from the initial design, moulding, pouring, casting temperature, solidification, and the final rate of cooling down to atmospheric temperature. Most alloys which consist of solid solutions possess dendritic structures "as-cast," and Admiralty gunmetal is quite a good example.

It has been amply shown that the best physical strength of bronze is reached at an optimum medium casting temperature. The exact temperature at which the peak occurs for any particular alloy is determined by the composition, casting temperature, shape of bar, method and speed of pouring, rate of cooling, and other variables. It is now well known, however, that the hardness and density increase as the casting temperature is lowered. Figures published by Rowe* show that the effect is partly one of rate of cooling. The more rapid the solidification, the higher the Brinell figure, and also the greater the density.

Density of Castings

It is this question of density which is so important where castings are subjected to pressure tests, and time spent investigating the conditions of running, to give the maximum density, is well spent. Where batches of large numbers of castings off the same pattern are going through, an excellent opportunity occurs of studying this matter, and checking the effect of varying casting temperature and alternative methods of gating.

Where a number of moulds are poured from one crucible or ladle, there must be a falling temperature gradient between the first and last poured. If the castings are dissimilar, they will naturally be arranged so that those requiring the highest pouring temperature will be cast first. Where the castings are identical, then a safe pouring range will have to be found and adhered to. With small work and optimum running and gating conditions, this latitude can be surprisingly large, as evidenced by taking the first and last casts from a batch of oil-sprayer bodies. Nine identical boxes, containing a pair of sprayer bodies were cast from a crucible. The pouring temperature of the first box was 1,170 deg. C., and the temperature of the last, 1,120 deg. C., a drop of 50 deg. during the time taken to pour the whole batch. The castings are illustrated in Fig. 3. The specific gravity of the complete casting poured first at 1,170 deg. C. was 8.73., whilst the last was 8.77. These castings require to be as perfect as possible, as they are machined all over, and are then subjected to a fairly high-pressure test. Any drop in specific gravity is immediately reflected in an increase of rejects on test. This high and consistent density figure is only possible owing to the fact that the casting is relatively small, and is run very direct, with an ample gate and head. The bulk of metal in the runner is actually greater than the casting. Larger and more intricate castings are a very different proposition, and are much more affected and susceptible to casting temperature.

The tendency of the moulder is to work with too small a runner and gate. This is possibly due to unofficial pressure from the fettling-shop end. The official view should be that, whilst obviously desiring to keep the fettling costs down as much as possible, it is false economy and bad practice to permit small gates or runners, with the consequent loss due to "piped" and unsound castings, or subsequent failures on water test. Sometimes "flows" or feeding heads are used unnecessarily, and to the detriment of the casting. Where used indiscriminately, or without appreciation of the principles involved, they can do far more harm than good. An example is shown in Fig. 4, which is a pipe-end in flange metal. This was originally run from the bottom with a small ingate. A "flow" was taken off from the top of the casting, at right angles. When cleaned off, the casting was found to be "piped" where the top "flow" was broken off. This can be seen in the illustration. A sunken place was also found a short distance below the top, extending all round the inside. There were contraction cracks also at several places round this band, as shown in Fig. 5. Repeating this without any attempt to provide a feeding head, but after considerably enlarging the ingate and down tube, put matters right.

FIG. 11.

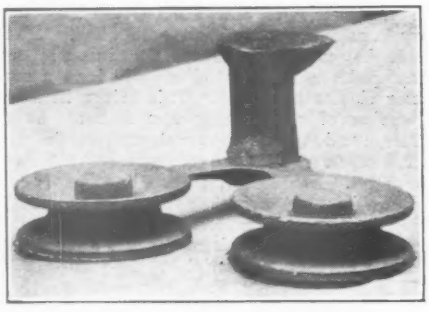


FIG. 12.

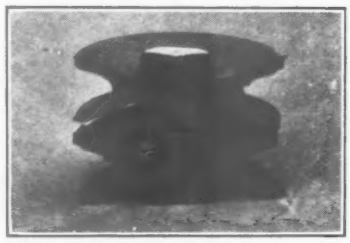


FIG. 13.

FIGS. 11, 12 AND 13 SHOW A DEFECT IN TROUBLE (11); AN IMPROVED METHOD OF RUNNING (12), AND THE RESULTANT GOOD EFFECT (13).

Keeping in mind the principle that it is essential to obtain progressive and uniform solidification back over towards feeding points, it is sometimes necessary to resort to some chilling device to even-out the rate of solidification of thicker sections. The trouble that can be met in this direction is shown by an example where a solid boss of 2-in. dia. occurs on a casting of only ⅜-in. section. Fig. 6 illustrates a bridge piece for a valve. It might be argued that the trouble is intensified by the lack of a fillet, but whilst this is so, a fillet does not eliminate the trouble. The only satisfactory method of securing this sound has been to run with a very ample "gate" and chill the boss, as shown in Fig. 7. The same trouble is met with where end flanges are thickened up out of all proportion to the body of the casting, and this, it should be noted, is an increasing modern tendency. Flanges of 1 in. thick, for instance, are found on small "T" or branch pieces, where the general body section is a matter of $\frac{3}{16}$ in. or $\frac{1}{4}$ in.

Another example of a casting which gave trouble is shown in Fig. 8, which illustrates a strainer centre. This has a small boss on the centre hub, which is drilled and tapped to take a grub screw. The extra thickness at this spot apparently allows a lower rate of solidification, and the arms of spokes feed from this still liquid portion, giving rise to a feeding contraction cavity (Fig. 9). The only remedy is to speed up the rate of solidification to that of the arms by inserting an internal chill.

Another type of trouble occasionally met with is the use of too many or redundant ribs on castings. A casting such as that illustrated in Fig. 10 can give considerable trouble. The thin flat rib cools more quickly than the body of the casting, and the solid contraction tends to disturb or even rupture the crystallisation where it joins on to the body, with the result that it is difficult to avoid leakage on test at this junction. An application of what is known as "pencil gating" is found to work very well on certain types and shapes of castings. Fig. 11 illustrates a trolley wheel, which suffered as shown. By running these on the thin flange, as illustrated in Fig. 12, with a runner an inch by an eighth, these were obtained quite sound, as shown in Fig. 13.

(To be concluded.)

* FOUNDRY TRADE JOURNAL, June 7, 1934, page 363.

Imported Cast-Iron Baths

The Import Duties Advisory Committee give notice of an application for an increase in the import duty on cast-iron porcelain enamelled baths. Any representations which interested parties may desire to make should be addressed to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, Westminster, S.W.1, not later than June 6.

MESSRS. JOHN WALKER & COMPANY, of Greenock, have placed an order with Messrs. Simon-Carves, Limited, Cheadle Heath, for a new boiler plant. The contract comprises three 30,000 to 45,000 lbs. per hr. boilers fired by chain-grate stokers and working at 315 lbs. per sq. in.

British Industries Fair

FURTHER EXHIBITS AT CASTLE BROMWICH

The attention of foundry executives visiting Castle Bromwich is directed to the following stands, which contain exhibits directly connected with their industry.

GEORGE SALTER & COMPANY, LIMITED, West Bromwich

Whilst there is an impressive display of springs and roller bearings on the stand (A. 501/400), the foundry technician will be attracted to the range of testing machines shown, which includes the improved pattern of the British Cast Iron Research Association's approved instrument for testing sand cores.

Under the Home Office Regulations, building cranes must be provided with a safe load indicator, which will show to the driver by means of a visible signal when the maximum safe load for any angle of the jib is approached and, by means of an audible signal, when it is exceeded. For fixed-jib cranes the Salter crane weigher can be used for warning the operator of excessive load, as well as for showing the actual weight of the load for record purposes. It will be readily understood, however, that a variable-jib crane will lift and be stable with a greater load when the jib is nearer the vertical than when the jib is nearer the horizontal. In other words, the further out the jib reaches, the smaller the load that can be lifted. Thus, a perfectly safe load may be lifted with the jib at a certain angle, which can become dangerous if the jib be derricked out. A suitable indicator, therefore, has to take into account not only the actual weight lifted, but the angle of the jib also, and must be approved in writing by H.M. Chief Inspector of Factories. The Salter safe-load indicator which is being shown has been designed not only to be supplied with new cranes, but for simple attachment to existing cranes. No structural alterations to existing cranes are necessary, the fixing does not require any skill, and can be done in a short space of time, which is an important point if, as is often the case, the crane is fully occupied.

The machine, which has the approval of the Home Office, indicates in three ways. A white or green pilot lamp lights as soon as the warning device is put into operation, showing that the electrical circuit is complete. When the maximum safe load is approached, the pilot light goes out, and the red warning goes up and stays alight until the load or radius is decreased. As soon as the load exceeds the maximum safe load, the hooter is sounded in addition to the red-light warning.

Four crane-weighing machines are on view, representing a standard selection of nearly 30 different capacities and sizes. Those to be seen range from 10-cwt. machine, with a 5-in. dial, up to the largest machine made, 100 tons capacity. These machines can be adapted for many different circumstances—the normal use is attached to a crane hook. On the other hand, they can be modified for use on overhead runways, when a piece of the rail is attached to the machine, and the weight is read when the load is run on to this live piece of rail.

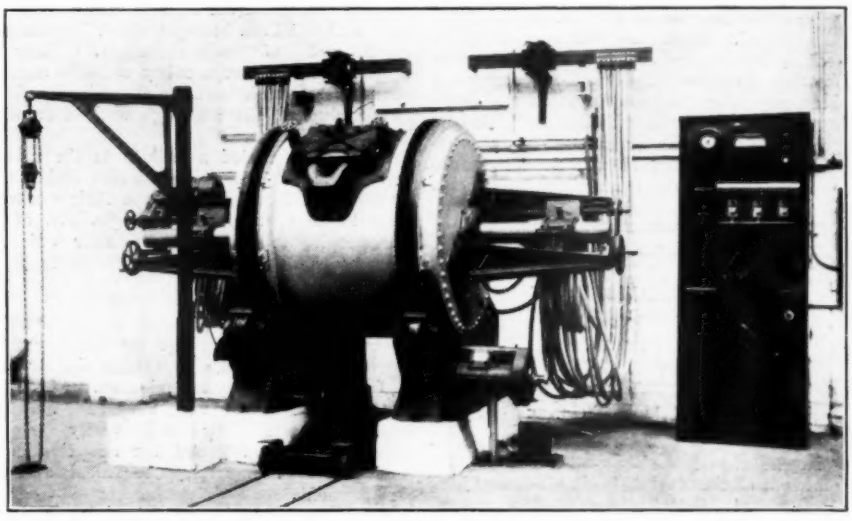
Platform weighing machines are made in capacities from ½ cwt. up to 2 or 3 tons, with or without counting devices. A Dormant machine is on view.

PNEULEC, LIMITED, Smethwick, Nr. Birmingham

As representative of their line of foundry equipment, Pneulec are demonstrating on Stand No. C.723 moulding and sand-preparing machines.

The moulding machine is of the jar roll-over, pattern-draw type, with the rolling-over and pattern-drawing operations controlled by oil. The machine demonstrated has a turnover plate, 20 in. by 36 in., and a capacity of 750 lbs. It is the smallest of this series of machine, and available in sizes up to the 8-ft. by 10-ft. table, 20-ton capacity machine. It is understood that Pneulec have one of these large machines on order at the present time. An interesting feature proving the accuracy of the machine demonstrated is that the mould can be put back on to the pattern and stripped again without sign of a crush.

Of their sand-preparing machines, Pneulec are demonstrating the Rover sand mixer and Silkysand disintegrator. The Rover is a general-utility machine, and has been seen at the B.I.F. in previous years. This machine has been so widely adopted that no description is necessary. The Silkysand is a distintegrator which produces the finest grade of facing that could be required, and the design of which eliminates any possible breakdown due to scrap in the sand. If scrap be shovelled in with the sand, it passes through quite harmlessly. A further advantage is the saving in horse-power. The machine will take as much sand as can be shovelled into it, and yet requires only a 3-h.p. motor. The Silkysand disintegrator has been incorporated in a large number of sand plants, where it completes the final conditioning of the sand. Regret will be expressed that it has not been found possible to show the Wheelabrator.



The Birlec-Detroit Rocking Arc Melting Furnace (1,000 lbs. capacity), by Birmingham Electric Furnaces, Limited.

BIRMINGHAM ELECTRIC FURNACES, LIMITED, Erdington, Birmingham

Probably of chief interest among furnaces exhibited by this firm on Stand C. 334 is the "Birlec-Detroit" rocking electric-arc melting equipment. This is a furnace essentially identical with the Detroit melting equipment which has been well known for over sixteen years in America, in which country it has achieved recognition as an instrument of the very first importance in both ferrous and non-ferrous foundry work. By an agreement between Messrs. Birmingham Electric Furnaces, Limited, and the Detroit Electric Furnace Company, the same equipment, with the results of this extensive experience as a basis for its design, is now available to users in the British Isles, the Dominions and certain other countries, entirely British made and associated with the best service which an organisation such as Birlec can provide. It is reasonably anticipated, therefore, that this development will have a pronounced effect on British ferrous and non-ferrous foundry technique, and the exhibition of a typical equipment at the British Industries Fair this year, for the first time, therefore should be of exceptional interest. Changes of steel are actually being melted and poured at the Fair.

Some outstanding Points

The advantages of the Birlec-Detroit rocking electric-arc furnace are too numerous to mention in detail here, but attention may be drawn to certain of the more outstanding points. The arc is formed on the axis of a horizontal, cylindrical chamber which is rocked about its axis continuously during melting. In this way exceptionally rapid heating of the metal is obtained, and it is noteworthy that the output of Birlec-Detroit furnaces is appreciably superior to that of any other similar equipment of corresponding size.

The rocking action of the chamber also has the important effect of ensuring strictly uniform distribution of all constituents throughout the metal so that the product is absolutely homogeneous and free from local defects of any kind. This fact, of course, represents a genuine economy by making possible the production of an improved quality of metal with much greater consistency, but it should also be remembered that the Birlec-Detroit furnace will melt charges of cheap scrap material, such as borings, turnings, etc., with negligible loss, so that a further important saving may be effected in this way.

In general, the Birlec-Detroit furnace is noteworthy for reducing metal losses, ensuring uniform composition of the melt, providing a rapid output of metal and permitting exceptionally accurate control. Over six hundred of these equipments are already in use in brass foundries and in the production of high-duty, malleable and other special grades of cast iron. Full information regarding the characteristics and performance of the furnace will be available on the stand, the smallest model in the range being exhibited together with photographs and other data relating to larger sizes.

In addition to the foregoing important working exhibits a small forced-air circulation low-temperature furnace for tempering and similar processes will be shown, while photographs and technical data will be available dealing with a very wide range of Birlec industrial installations covering practically the whole field of heat-treatment and melting.

MOND NICKEL COMPANY, LIMITED, Thames House, S.W.1

The exhibits on Stand D. 408 this year comprise a varied selection of applications of nickel steels, light alloys containing nickel, nickel cast iron, nickel iron and nickel non-ferrous alloys.

Round the sides of the stand there will be an explanatory flow sheet which should prove of very great interest to visitors. This flow sheet indicates all the stages in the extraction of nickel from the nickel-copper sulphide ores obtained in Canada. In general, the process may be familiar to many, but what is not so well known is that actually ten other metals besides nickel are obtained from this ore. They are platinum, selenium, tellurium, silver, palladium, gold, rhodium, ruthenium and iridium, and samples of each are shown in their appropriate places on the flow sheet.

In the section devoted to the light alloys containing nickel there will be an automobile cylinder head of "Birmasil special," a nickel-aluminium silicon alloy containing about 3 per cent. nickel. It is an excellent casting alloy with high-tensile strength in the as-cast condition, and has the added advantage of possessing a low coefficient of expansion.

Developments in nickel cast iron will be illustrated in the cast-iron section. Heat-treated cast-iron cylinder liners, which usually contain from 1 to 2 per cent. nickel, will form part of this exhibit. They possess an excellent combination of hardness and strength properties. A new type of cylinder liner made of "Ni-Resist" will also be included. Recent suggestions that cylinder wear is largely due to corrosion are responsible for this development, as "Ni-Resist" has a very high resistance to both corrosion and heat. At elevated temperatures "Ni-Resist" holds its strength to a remarkable extent. Very interesting exhibits in this section will be the crankshafts of nickel cast iron containing 2 per cent. nickel.

Staffordshire Iron and Steel Institute

The annual meeting of the Staffordshire Iron and Steel Institute was held in Dudley on May 8, when Mr. J. T. Wright, Senior Vice-President, was unanimously elected President of the Institute for the ensuing year. Mr. Wright has for some years been an active member of the Council of the Institute, and is rolling-mill and melting-shop manager of the Earl of Dudley's Round Oak Works, Limited, Brierley Hill. Mr. T. G. Bamford, Principal of the County Technical College, Wednesbury, and Mr. D. Spittal were elected Vice-Presidents. The trustees of the Institute, Messrs. H. Silvester, J. E. Fletcher and J. Payton, were re-elected, as also was the honorary treasurer, Mr. Harold Piper. Upon the resignation of the secretary, Mr. G. H. Brooke, Mr. E. C. Rollason, of the County Technical College, Wednesbury, was elected to fill that position. A very hearty vote of thanks to Mr. Cookson, the retiring President, was unanimously passed for his two years' hard and successful work on behalf of the Institute, and he was elected to the Council.

Catalogue Received

Plastic Refractories. Bearing the caption "Lowering Heat Costs," J. H. Sankey & Son, Limited (Canning Town), The Hill, Ilford, Essex, have published a 12-page booklet dealing with Pyruma plastic fire cement. One of the illustrations is indeed remarkable, as it shows that deterioration in a firebrick wall can set in before the application of heat. The booklet contains many testimonials from a variety of industries. A covering letter says that the brochure is available to our readers on application, together with a free working sample.

A Centenary Luncheon

HENRY WIGGIN AND COMPANY'S CELEBRATION

Dr. E. L. Burgin (Parliamentary Secretary to the Board of Trade) was the principal speaker at a luncheon held at the Grand Hotel, Birmingham, yesterday in celebration of the centenary of Henry Wiggin & Company, Limited, Birmingham. Lord Weir presided.

Proposing the toast of "Trade and Industry," Dr. Burgin said that the expansion of the consumption of nickel did not merely mean there had been the same expansion of armaments in some parts of the world. By far the greatest increase in the use of nickel had been due to the motor-car industry. In the opinion of His Majesty's Government it was an anomalous position that they should expect the producers of primary products to sell at cost or below to consumers who passed large dividends at the end of the financial year. That was not a wise system or wise economy, and efforts would be directed to seeing that there should be a more equitable and balanced economy under which even the much-maligned producer of the raw material and the primary product, agricultural or otherwise, would receive a fair reward for his labour and his endeavour.

In the past few years this country had passed from being a dumping ground into one which held up to auction the right to enter its markets. That had not been brought about by means of a tariff wall of undue height. They had endeavoured to have a policy of tariff regulation administered with moderation and with fairness to producing, consuming and merchanting interests alike.

Dr. Burgin added a tribute to the old-established firms of this country which had managed by skill and foresight to adapt their works from time to time, to retain the goodwill of their workpeople, to accommodate their output, to increase their sales and to continue to flourish.

Conditional Prosperity

Sir Felix Pole, responding to the toast, said that a hundred years ago the country successfully passed through a depression similar to that which it had recently experienced. At that time conditions of labour were very bad, and it was good to note they had vastly improved. Prosperity then followed the adoption of Free Trade, plus industrial, mechanical and world development.

This country had reverted to Protection and prosperity. There was a vast improvement in the trade of the country. But he should describe the present situation as one of conditional prosperity. It was hopeful that they were thinking about their problems and facing them. He hoped that in the process of thinking they should not change their Government. He hoped that they should stick to the Government, and he was anxious that they should stick to their policy. Industries which had been established or extended as the result of Protection must be assured that they were going to have a continuance of that policy.

A New Laboratory

Mr. Robert C. Stanley (President of the International Nickel Company of Canada), who also responded to the toast, said it was intended to erect a new and well-equipped research laboratory in Birmingham, which would, he hoped, prove to be of mutual benefit both to the Nickel Company and to consumers of the metal. They of the nickel industry, in common with other industries, looked upon war as a serious threat to the orderly and successful development of their enterprises. During the past fifteen years the company which he represented had devoted a great amount of time, energy and money in developing applications for nickel and nickel alloys in the fields of transportation, communication and manufactures. As a result, it had established important markets and expected to increase these markets and to add new markets. Thus it was apparent that the recovery of trade and industry from the disorganisation and chaos following the last war, and their future progress as well, depended essentially on the maintenance of world-wide peace. He would therefore express the hope that the world might be allowed to progress without such interruptions and the necessity for readjustments as had been experienced during post-war years.

The toast of "The Guests" was submitted by Lord Melchett and responded to by Mr. Geoffrey Lloyd, M.P., and Lieut.-Colonel W. H. Wiggin.

The toast of "The Chairman" was proposed by Mr. D. Owen Evans, M.P. Lord Weir responded.

Patternmaking

(*Concluded from page* 344.)

patternshop. This machine can have 30-in. or 36-in. dia. saw wheels, with the motor built into the main frame, directly on the spindle of the bottom saw pulley. Rubber tyres, vulcanised on to the surface of both saw wheels, can be canted to the desired angle. There are ball bearings throughout, the ball bearing guides reducing to a minimum the friction on the back of the saw blade, and consequently reducing the saw breakages due to crystallisation of the blade. The machine is completely encased, the only part exposed being between the table and the guide, and has push-button controls and a foot brake.

The wood-working lathe is too familiar to need much description. The latest type of electrically-driven lathe has the outstanding advantage that no countershaft is required. The motor can be built into the machine and the belt transmitting the power to the headstock enclosed in the main columns, practically every class of turning being done either on the inside or outside face plate. A disc sander is indispensable to the economic working of any patternshop. The amount of work done by these machines is remarkable. They will sandpaper or grind to size practically any straight or angular work, as well as a wide variety of internal and external radii and bevel work. The table, which can be canted at any angle up to 45 deg., has scales and angle graduations for accurate setting. The universal pattern miller can be a great labour saver, and it is particularly useful in the larger marine shops. The latest design has a wide range of movement, and a great many jobs which would be slow and laborious by hand are actually cut in a few minutes.

There are many patternmaking and moulding labour saving devices which could be adopted without much, if any, increase in moulding costs, provided the two departments co-operate in the right spirit, and this can only be done by having the two departments under the same supervision. Those associated with the manufacture of patterns and castings must continue to develop more ingenious and cheaper methods of production design, and this can be accomplished if the patternshop and foundry work in close co-operation. These departments working together could produce castings of a design which would be practical without being elaborate, and buyers would probably find the saving in costs far beyond their expectations.

With the foundry and patternshop under the same supervision, and with co-operation between the drawing office and foundry departments harmonious, satisfactory and advanced methods of pattern construction should repay many times over their initial cost, and the moulder will be assisted in accuracy, speedier production, less fettling charges, and more uniform castings.

Refractories in the Foundry*

By H. C. BIGGS (Bonnybridge)

In approaching the subject of the suitability of refractory linings for cupolas it seems desirable to begin with a review of some of the more important properties of refractory materials; to pass on to consideration of the conditions obtaining in the cupola, and finally to offer some suggestions for making the best use of the materials available, bearing in mind their limitations and the conditions to be met.

Under the heading of refractories may be classed (*a*) the silica-alumina series, which includes silica, fireclays, aluminous materials such as bauxite, diaspore, sillimanite, corundum, etc.; (*b*) chrome; (*c*) magnesite; (*d*) silicon carbide or carborundum; (*e*) the rare earths, such as zirconia, and (*f*) spinels. Of these, only parts of the silica-alumina series have been generally adopted for use in the foundry. The reason for this limitation may possibly be found in the comparatively high initial cost of the other materials, though lack of data as to their suitability may also be an important factor. Be that as it may, the silica-alumina refractories are those universally employed in the foundry, and the discussion will be mainly confined to them.

Fireclays

Silica and alumina in a variety of forms occur naturally in varying degrees of purity, and compounds of these two, together with smaller quantities of other elements form the base of most of the earth's crust. Included in these compounds, and intermediate in composition, lie the fireclays, these being the products of the decomposition of silicate rocks, particularly of the felspathic type. In its purest form fireclay has a composition corresponding empirically to a formula $Al_2O_3 . 2SiO_2 . 2H_2O$, which would give rise to a fired product with an alumina content of approximately 45 per cent. Actually, however, the majority of fireclays in general use vary considerably from this figure, most of them containing quantities of other minerals, notably quartz, felspars, mica, iron, and lime-bearing minerals. While the chemical composition of a clay determines its refractoriness and may influence other of its properties, it cannot be accepted alone as a criterion of the behaviour of a brick in service, the characteristics of a firebrick being largely dependent upon the grading of the raw materials, the method of making, and the temperature and duration of burning. These properties are not fixed invariably by the nature of a given fireclay alone, but it has to be borne in mind that it is not possible to change one characteristic of a brick without also affecting most of the others, sometimes unduly so. While, therefore, types of bricks are produced which are designed for specific service, to offer greater resistance to some destructive agency, the average commercial firebrick represents a compromise in properties, dictated by the general demands made by industry as a whole.

Service Behaviour

Of the factors which affect the service behaviour of firebricks one may take:—(*a*) Refractoriness; (*b*) resistance to deformation under load at working temperatures; (*c*) volume changes at working temperatures; (*d*) spalling resistance, and (*e*) resistance to corrosion and erosion by slags, etc. Firebricks, as would be expected from their constitution, differ from pure substances in that they have no definite melting point, but soften progressively over a range of temperature. The refractoriness (or softening temperature) has therefore to be defined.

More important than this property, however, is the capacity of the material to withstand load at high temperatures. If a brick is subjected to pressure and its temperature steadily increased, it is found that deformation begins to take place at a temperature considerably below that of its ordinary softening point, and the rate of subsidence increases rapidly as the temperature rises still further. Both the refractoriness and under-load characteristics are influenced by the amount of fluxes present in the brick, but the deformation under load further depends also on the physical structure of the brick, its burning temperature and the atmosphere of the furnace in which it is used.

TYPICAL CUPOLA FIREBRICKS

	A.	B.
Silica	62.83	56.48
Alumina	31.67	36.73
Titanic oxide	1.14	0.94
Ferric oxide	2.68	4.48
Magnesia	0.39	0.42
Lime	0.60	0.47
Alkalies	1.01	0.51
	100.32	100.03
Cone	31 (1,690 deg. C.)	31 (1,690 deg.C.)

A well-made brick burned at a sufficiently high temperature in manufacture, has a reversible thermal expansion which, with the exception of the highly siliceous materials, is fairly regular, and amounts to approximately 0.5 per cent. at 800 deg. C. and about 0.7 to 0.8 per cent. at 1,400 deg. C. With some bricks, however, it is found that before this latter temperature is reached permanent contraction begins to take place. This may be caused by excessive vitrification occurring at these temperatures, but it is more usually the result of inadequate firing treatment. Whatever the reason, a large after-contraction in a firebrick is objectionable and may lead, as a contributory factor in certain other phenomena, to considerable trouble in service.

CUPOLA RAMMING COMPOUNDS

	A.	B.
Silica	87.98	88.80
Alumina	9.85	8.55
Iron oxide	0.97	0.65
Titanic oxide	0.84	0.44
Lime	0.34	0.36
Magnesia	0.18	0.31
	Per cent. 100.16	99.11
Loss over 109 deg.	3.34	2.23
Cone	31 (1,690 deg.C.)	31 (1,690 deg.C.)

Spalling

Spalling usually defined as the cracking and splintering of refractories to such an extent that pieces break away from the body of the brick, may be considered as falling into three types:—(*a*) Mechanical, (*b*) thermal and (*c*) structural. Of these, the two latter are in practice often found closely associated. Mechanical spalling is mainly the effect of compression in the furnace structure, caused by expansion of the firebrick, and is generally to be attributed to furnace design and not to the refractory material employed. Thermal spalling takes place as the result of stresses set up by temperature gradients in the brick, and is therefore related to the rapidity and range of temperature fluctuations in the furnace. While the complete mechanism of thermal spalling is not known with accuracy, it may serve to indicate some of the properties of a brick which are known to enter into the action. These are the coefficient of expansion, strength and elasticity, thermal diffusivity.

Considering a brick which is heated from one end, it will readily be seen that a temperature gradient is set up and the heated layers expand. The severity of the stresses produced naturally depend to a great extent on the coefficient of expansion, and if this were sufficiently low, it is evident that no spalling would occur. If a brick were possessed of sufficient elasticity, then whatever the magnitude of the expansion, the stresses would be removed by the brick material accommodating itself to the irregular changes in volume; and, finally, the temperature diffusivity assists materially, in that it reduces the sharpness of the temperature gradient and the tendency to rupture is lessened. In a brick designed to withstand thermal spalling, then one would expect to find a low coefficient of expansion, the maximum flexibility to be obtained without undue sacrifice of strength, and good heat diffusivity—a combination of properties not easy to realise and control.

The third type, structural spalling, is brought about by reason of a change taking place in the physical structure of the surface layers of the brick exposed to heat. These changes may be brought about by:—(*a*) The removal of residual contraction in the material, thus forming a layer denser than the body, which is in many cases the result of inadequate heat-treatment for the duty, and (*b*) vitrification, either inherent or through absorption of fluxes, producing a dense, glassy layer, the formation of which may be accompanied by contraction and alteration in properties. In both cases the portions so formed tend to split away from the brick.

Slag Attack

The destruction of refractory materials by slag attack constitutes one of the most difficult problems associated with their use. In practice a pure chemical effect is not often encountered, the action more usually being of a physico-chemical nature—a combination of corrosion and erosion.

When a layer of slag is formed over a firebrick wall, the reaction which takes place tends to proceed to equilibrium, and whether or not the slagging effect is severe depends upon several factors, which are closely linked together:—(*a*) Constitution of brick and slag; (*b*) the speed of the reaction; (*c*) diffusion through the melt; (*d*) the viscosity of the melt, and (*e*) physical structure of the brick.

The tendency is towards the formation of liquids with low melting points. If the reaction proceeds slowly, or the melt formed is viscous, the attack may be comparatively sluggish, and even though the rate of reaction were high initially, if the melt is viscous, attack may be retarded. But if the reaction proceeds rapidly and the liquid formed is mobile, it may be removed quickly from the point of reaction by gravity or other means, and fresh surfaces of the refractory material are exposed to attack. Since the reaction rate and the speed of diffusion increase, and the viscosity of the reaction product decreases as the temperature is raised, it will be seen that high temperature promotes rapid slagging action. It frequently happens that the presence of a moving charge in contact with the furnace lining assists in the removal of the reaction product to such an extent that destruction becomes rapid, and frequent repairs are necessary.

Plastic Refractories

The only other refractory materials commonly employed in the cupola are the plastic compounds used for the preparation of rammed

* A Paper read before the Edinburgh Section of the Institute of British Foundrymen, Mr. William Wallace presiding.

linings and the repair of the damaged portion. Ramming materials may be separated into two groups; natural products and synthetic mixtures of two or more materials. Practically all of them are siliceous in character and, whether natural or synthetic, may be regarded as clayey sands. Factors related to the ramming compounds themselves, which will determine their durability, are:—(*a*) Chemical composition; (*b*) refractoriness; (*c*) drying shrinkage and volume changes when heated; (*d*) initial sintering temperature, and (*e*) hardness after firing. To these must be added "workability," as on this depends partially the efficiency of the ramming operation.

Plastic ramming compounds have an analysis fluctuating between SiO_2 85 to 95 per cent. and Al_2O_3 5 to 10 per cent., plus smaller percentages of fluxes, and their refractoriness is generally of the order of Cone 31 (1,690 deg. C.). If the material be used in the form usually recommended (at a consistency and dampness which causes it to ball up solidly under hand pressure) the drying shrinkage is not high. The compounds generally consist of quartz grains surrounded by a clayey matrix, and the volume changes on heating are fairly complex. The curve of the volume changes is everywhere the resultant of the separate changes of the quartz and the clay constituents. It rises steeply but fairly regularly to approximately 600 deg. C., from which point contraction gradually sets in, increasing rapidly at approximately 900 deg. C. where the contraction and vitrification of the clayey portion begin to assert themselves. At higher temperatures, some quartz will combine with the fluxes to form glass, but the majority of it will invert slowly to cristobalite and tridymite, the process being accompanied by permanent expansion. After the first few heats, therefore, the expansion of the heated portion of the lining will have changed; it will then be approximately reversible, and resemble that of a semi-silica product.

Though it may be difficult to obtain in practice, a combination of low sintering temperature with refractoriness is desirable, in order to impart to the exposed surface sufficient hardness to resist abrasion and mechanical abuse. After they have been tamped into position, and heat applied, rammed linings are naturally subject to deterioration by spalling and slag attack in the same way as brick linings.

Working Conditions

Turning now to the conditions which the refractory lining has to withstand, one may for the present purpose consider the cupola as being made up of three sections, namely, that lying between the charging door and the beginning of the melting zone, the melting zone itself, and the crucible. In the charging zone, the lining must be able to stand up to the mechanical abuse due to charging, the abrasive action of the descending materials, and nearing the melting zone this action together with high temperature. It is in the melting zone proper, however, that the greatest strain is thrown upon the refractory material. The temperature reached in this section has been variously estimated, but general agreement places it in the vicinity of 1,700 deg. C. It is not easy to form a clear mental picture of the conditions in this part of the cupola, but it is certain that the lining is subject to exceedingly high temperature, and severe attack by slags; at the temperature obtaining these are very fluid and active, and the surface of the lining is approaching a plastic state.

Conditions in the lower zone are not so severe; the temperature is lower, and it is not subjected to the action of the blast. Temperature changes may be quite severe, however, in the dropping-bottom type. A good lining means longer service, more efficient operation and lower maintenance charges. Equally important, however, as affecting the life of the linings, are the operating conditions. It is found that quite diverse results are obtained in separate foundries with very similar refractories, and this is scarcely surprising, for it is acknowledged that there exists a considerable variation of conditions in the cupolas. Factors related to the cupola which will affect the life of the lining are:—(1) Design, arrangement of tuyeres, etc.; (2) blast velocities; (3) quantity and type of flux added; and (4) duration and rate of melting.

Much has been done recently towards the production of more uniform conditions in the melting zone, and possibly nothing can do more to provide more regular results than rigid control of operation, with regard to the preparation of the charges, the melting rate, etc. The production of a brick which meets successfully any specific purpose arises from study of the actual

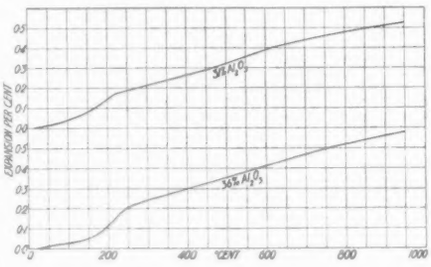


Fig. 1.—Expansion of Fire-brick.

service conditions. It is difficult to simulate these conditions in the laboratory, and tests which are devised can usually be accepted only as a guide in the production and maintenance of high quality; the acid test is the behaviour of the brick in service. The foundryman, by keeping records in respect of a cupola, may not only find therein the explanation of premature failures, for which some change in the conditions may well have been responsible, but will also assist in the accumulation of useful knowledge regarding working conditions.

Rammed and Bricked Linings

A question which frequently arises in connection with cupola operation is that of the respective merits of brick and rammed linings. In view of results obtained, one hesitates to be dogmatic, but from consideration of the properties

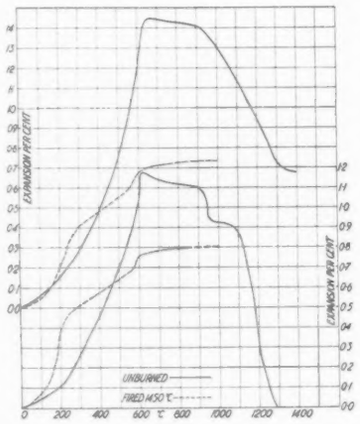


Fig. 2.—Expansion of Plastic Refractories.

of the two materials and the conditions to be met, one would expect that a well-made brick used in conjunction with suitable bonding material should yield more regular results. Though the use of ramming compounds tends to give a monolithic lining, they are more difficult to build up than bricks, and the possibilities of irregularity are therefore increased. A ramming material must be of such composition and grading that it can be rammed easily and will possess good inherent bonding strength. The production of a uniform lining, and hence its durability in use, naturally depends very largely upon the efficiency of the ramming operation, and this in turn upon the skill of the men employed. Drying has to be carried out with care, so that the removal of mechanical and combined water is not too fast, otherwise peeling and flaking may occur. When the lining is heated, a vitrified layer is formed on the inside surface, but as the temperature drops fairly quickly across the thickness of the lining, it does not penetrate very far; the material behind this remains comparatively soft and friable. The formation of this layer is of great importance, and if its hardness is inadequate and it is broken, destruction by abrasion may be very severe locally.

With firebrick linings, it is generally the practice to use the same brick throughout the cupola. This is probably considered to be the most economical procedure viewed in the light of experience gathered up to the present, but, bearing in mind that the conditions vary in the different zones, one feels that the point is one worthy of further consideration.

Differing Requirements

For the upper portion of the lining, where mechanical considerations are the most important, a brick of normal refractoriness, good spalling resistance, and possessing a good tough texture—a somewhat elusive quality—should give adequate service. In the melting zone, however, the conditions demand a high-grade refractory capable of withstanding the iron-lime slag at very high temperatures. Whether or not the adoption of higher-grade bricks for this zone would give increased service and reduced maintenance charges commensurate with the high initial cost, is a matter for experiment. Even though attempts so far made may not have been attended by outstanding results, this should not be allowed to shelve the question indefinitely. It might be said against this, that, whatever material has been used in the melting zone, it had always to be repaired after a melt to ensure a reasonable life for the lining. Certainly no material has yet permitted continuous use of a cupola without patching, but, since with each melt a certain amount of the lining is won by the slag over and above the removal of the patch, it is quite reasonable to assume that, if this could be restricted, not only would the effective life of the lining be increased, but the amount of patching required would be reduced. A lining is as strong as its weakest point, and it is well known that the joints between the bricks have constituted the most vulnerable part. With open joints, the deterioration of the lining, by selective corrosion or by increased sensitivity to spalling, is accelerated, the corrosion at first giving rise to the condition known as "cobbling," so-called because of the resemblance of the rounded bricks to worn cobble-stones.

The elimination of open joints has received much attention, and progress has been made along two distinct lines—the production of bricks of better shape and more uniform size, and provision of more suitable bonding materials. Linings should be made with thin, tight joints, so that they approximate to the monolithic condition. In this connection it is not inappropriate to point out that much trouble is caused by chipping of the bricks through careless handling in transport and storage; a little attention given to this point will more than repay itself.

Bonding Materials

There is no lack of variety in the range of bonding materials available, and they may be broadly divided into two classes:—(*a*) Straight cements, of composition similar to the bricks, maturing at temperatures in the region of 1,200 deg. C. upwards, and possessing no special features; and (*b*) special refractory cements, usually synthetic in character, which are compounded special properties.

Some of these latter—for which rather extravagant claims are sometimes made—might be

(*Concluded on page* 354.)

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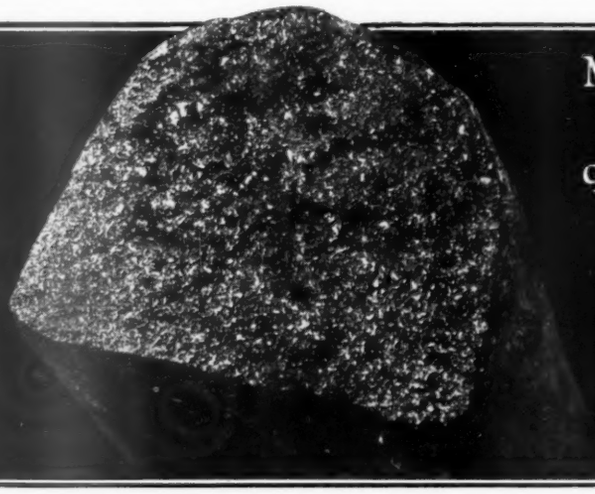

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Atomic Arrangement in Metals and Alloys

INSTITUTE OF METALS ANNUAL MAY LECTURE

Prof. W. L. Bragg, F.R.S., delivered the twenty-fifth annual May Lecture before the Institute of Metals on Wednesday, May 8, in the hall of the Institution of Mechanical Engineers, London.

The lecture dealt with the inner structure, or atomic arrangement, of metals and alloys. Prof. Bragg said that X-ray analysis has given us a new method for examining solid bodies, because by observing the way in which these rays are scattered or "diffracted" by the regular pattern of a crystalline solid, the arrangement of the atoms in the solid can be deduced. The new discoveries about the structure of metals made by X-ray analysis formed the subject of the May Lecture given by his father, Sir William Bragg, to the Institute of Metals in 1916. Prof. Bragg had been asked by the Council to take up the tale and give an account of some of the developments which have taken place since that date.

The great technical importance of metals and alloys makes any contribution to a knowledge of their fundamental structure a matter of considerable interest. Three main features of structure may be distinguished. There is first the atomic arrangement in single crystal grains of a homogeneous alloy which is in a state of equilibrium. There is in the second place the nature of the arrangement in an alloy which is not in equilibrium, but has been obtained in some other state by the quenching and annealing processes which are so widely used to give the alloy desirable properties. In the third place, there is what may be termed the "geography" of the alloy. By this is meant the shape and size of the crystal grains, their orientation relatively to each other, and the way in which blocks of the various different crystalline phases fit into each other if more than one is present. All these factors are of importance in determining the properties of the alloy, and all can be examined by X-ray methods.

"In so immense a subject," said the Professor, "I must confine myself to certain features, and I wish to limit my discussion to the first two factors described above. The third factor is of equal or even greater importance, but it is not so amenable to theoretical treatment, and I wish to show how the new knowledge of atomic arrangement can be made the basis of a theory, at any rate in outline, of alloy structure."

In general, when one metal is alloyed into another, a series of phases appear. Metal A dissolves a certain amount of metal B with a gradual alteration in properties as the proportion of B increases. At a certain composition, a limit is reached, and for greater amounts of metal B a new phase appears as separate crystals of quite different properties mixed with the first phase. Their relative amount increases till the whole structure consists of the new phase. Regions of single and double phase alternate as the composition varies from pure A to pure B. These phases are the nearest approach in an alloy system to the chemical compounds formed by combining elements. X-ray analysis has shown that each phase has its own definite pattern, such as a cubical array with atoms at corners and centres, or at corners and centres of faces. The pattern changes from phase to phase. One of the most interesting of recent contributions has been a theory put forward by H. Jones which indicates the factors determining the type of pattern in each phase. The theory is only tentative and approximate, but it gives for the first time a reason for one of the most striking generalisations about alloy patterns to which X-ray analysis has led us. This is the empirical Hume-Rothery rule, which states that the ratio of free electrons to atoms in a structure is the same for alloys with the same pattern. Jones has shown how the alloy pattern affects the binding energy of these free electrons, and so has given a reason for the Hume-Rothery rule.

Another point brought out by the X-ray analysis is that the method of arrangement of the atom amongst the positions of the phase pattern can be varied widely. The phase pattern is an entity apart from the way the atoms are distributed, in marked contrast to ordinary chemical compounds. The study of the movements of the atoms amongst the positions, as affected by heat-treatment, can be made the basis of a very interesting theory. At high temperatures they sort themselves out into a regular alternation. The course of the transformation as temperature varies, its rate of attaining equilibrium, its influence on the specific heat and electrical resistance of the alloy, and many other features can be predicted theoretically and agree with experiment. These transformations explain many hitherto puzzling features of alloy phase-diagrams.

The importance of all this work is that it provides a basis for the chemistry of compounds formed between metals. Although an immense amount of knowledge about the properties of metals and alloys has been won, it is perhaps fair to say that a fundamental basis of this kind has hitherto been a real need. The determination of the arrangement of atoms in chemical compounds has caused us to view many of the generalisations of chemistry in a new light, and this has been conspicuously the case in metallurgy.

Refractories in the Foundry

(*Concluded from page* 352.)

described more accurately as semi-refractory, in that their melting points do not approximate to those of the bricks.

So far as the first type is concerned, the main requirements are high refractoriness, low shrinkage and good working properties. The special refractory cements are more expensive; the characteristics called for cover a wider range, and in general are more fully developed. They should be highly refractory, but possess a low vitrification point, and ensure, in the air-setting type, good bonding from ordinary temperatures, and in the others a good bond developing at temperatures of approximately 800 to 900 deg. C. They should be finely ground, easily worked, and exhibit negligible contraction on drying and burning. Judiciously employed, they can lead to improved service in certain types of installation.

The destruction of the melting zone is such that it must be made good prior to each melt, and as the consumption of material for this purpose is quite appreciable, it assumes a position of some importance in cupola economics. Practice in this respect varies somewhat, special patching compounds, ganister, clay plus fireclay scones, all being employed. The special materials closely resemble those ramming compounds previously referred to, and are mainly siliceous in character. They are, however, generally used in a more plastic condition than that commonly employed for ramming. There is probably considerable scope in this connection for experimental work in order to determine the most suitable materials and methods of application.

In the foregoing an attempt has been made to review the present position with regard to cupola linings. It is by no means the end of the story. Much work remains to be carried out, and no doubt more regular results will be obtained when there exists a better understanding of the working conditions in the cupola as well as extended experience of the various lining materials available.

Better Scrap Metal Outlook

(FROM A CORRESPONDENT.)

Two factors are working to improve the position in the scrap-metal trade—the firmer tendency in the market values of copper and spelter and the programme of restriction in output of the former metal. For a long time potential reservoirs of brass and copper scrap have remained untapped because of depressed prices, for dismantling and breaking up on any large scale have been almost out of the question with such a poor return on material sold. The margin is now a little better, for the few extra pounds on the price of copper have lifted scrap values, not far, but enough to make it worth while grading and sorting secondary metal for sale. Once launched on its career scrap will pass into consumption eventually, even though it may change hands two or three times first; the dealers will see to that, but for a long time now the trouble has been to arrange for recovery of old metal on anything like a decent scale.

As to the producers' scheme for curtailing output of copper, this is likely to play an important part in the fortunes of the scrap-metal trade, provided that the arrangements for cutting down production do not break down. Of recent years Bessemer copper from Chile and Rhodesia has been widely adopted, not only in this country, but on the Continent, as the primary raw material for the manufacture of sheets, plates, rods and many other products, and, on the basis of 1934 production and consumption, there was little or no surplus after consumers' needs had been satisfied. Just how the curtailment plan will operate is still a little uncertain, but, presumably, the cut will be all-embracing, the output of Bessemer being reduced in the same way as electrolytic. Both as to price and quality, good-grade secondary copper is the best alternative to Bessemer brands, and it is therefore very likely that in due course there will be an increase in the demand for scrap. In this brass will doubtless share, but the duty decision in regard to spelter will have some bearing on this, for if supplies are going to be more adequate and the price reasonable, consumers may be inclined to stick to their policy of buying virgin metal.

Another development calculated to increase the amount of scrap available is the increase in exports from the United States, made possible by the narrowing of the margin between the domestic and export price of copper. American scrap is not very popular in this country at the moment, for consumers have had reason to complain of the quality, but perhaps the slight improvement in values will prove to be the means of correcting this trouble. American shippers certainly have a wonderful opportunity of recapturing lost connections in this country if they care to take the chance which curtailment of copper production is likely to offer them, and the only thing that may upset their re-entry into this market is the interpretation placed by the Customs on the Act governing the application of the import duty on scrap metal. On the whole, however, the outlook for business in scrap is distinctly brighter, and it seems that after one of the worst spells in the history of the trade dealers may now look forward to a better time.

THE DIRECTORS of Messrs. John Brown & Company, Limited, report that, following the September launching, the work of fitting out the "Queen Mary" is proceeding satisfactorily. Trading results of the subsidiary Thomas Firth & John Brown, Limited, showed material improvement in 1934, and the company's position has been strengthened by the amalgamation of the interests in stainless and "Staybrite" steels, with similar interests in the English Steel Corporation, Limited. The trade in these steels continues to expand.

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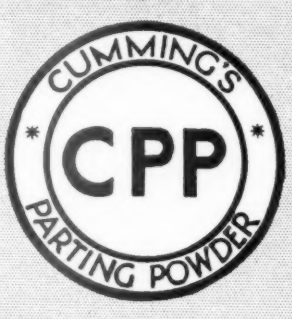

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This Week's News in Brief

Trade Talk

THE O. HOMMEL COMPANY, of 209, Fourth Avenue, Pittsburgh, Pa., after a long period of research, has developed Frit No. 924, a clear acid-resisting frit.

THE NEW ISSUE by General Refractories, Limited, of 200,000 10s. ordinary shares will be made at a price of 18s. 6d. per share. Half this number will be offered to existing shareholders.

IT IS REPORTED that negotiations are proceeding which are likely to result in the early conversion of the British (Guest Keen Baldwins) Iron & Steel Company, Limited, into a public company.

AT THE FALKIRK Dean of Guild Court, Messrs. R. & A. Main, Limited, Gothic Iron Works, Camelon, Falkirk, were granted permission to erect an addition to their works, which would be used as a photographic studio.

FIVE CONTRACTS have just been secured by the North Eastern Marine Engineering Company, Limited, Sunderland, and these, with the present orders booked, are sufficient to keep the works busy until the end of the year.

AT A MEETING of the Clydebank Dean of Guild Court, this week, Messrs. D. & J. Tullis, Limited, makers of laundry machinery, applied for, and were granted, permission to make extensions to their foundry at Kilbowie Iron Works.

THREE NEW NAVAL VESSELS built on the Clyde for the British Admiralty have been carrying out trials during the past week. The most important of these is the "Galatea" built by Scotts' at Greenock. The other two are the mine-layer sloop "Kingfisher," built at Fairfield, and the destroyer "Foxhound," constructed at Clydebank.

HUGE SINGLE-ENDED BOILERS, each weighing 95 tons, which are claimed to be the largest of their kind ever installed in Glasgow, will be fitted in the new Brocklebank liner "Marwarri," which, after launching by Messrs. William Hamilton & Company, Limited, Port Glasgow, this week went up the Clyde to have her machinery installed by Messrs. David Rowan & Company, Limited, at Finnieston.

SPEAKING AT THE annual dinner of the Middlesbrough and District Association of Foremen Engineers and Chief Draughtsmen, Mr. W. H. Crosthwaite, a director of Messrs. Dorman, Long & Company, Limited, and chairman of the Tees Development Board, announced that the Board is at present negotiating with three foreign firms, and he had the greatest hope that one of the three, at any rate, would be induced to establish a new plant on Tees-side.

THE NETHAN IRON WORKS, Motherwell, recommenced operations on May 20, after being closed down for some time for the production of puddled iron for the manufacture of special grades of galvanised sheets. The works, which were originally built by a Motherwell group soon after the war, is one of the few remaining puddling plants in the district, all of which are now subject to intermittent work. They are now the property of Messrs. Frederick Braby & Company, Limited, the well-known firm of engineers and galvanisers.

THE ARMOUR-PLATE MILL at the Parkhead Forge of William Beardmore & Company, which has been standing idle for more than three years, resumed operations on May 14. The firm has received large orders for armour plate for naval contracts for the Admiralty. The plate mill was specially designed and constructed for the production of armour plate, and is one of the best equipped in the whole country. All the plant received a preliminary tuning-up before being put into operation, and the number of men employed will be increased daily until full capacity is attained. It is stated that the orders ensure continuous employment for a long period. Parkhead Forge is now busier than it has been for a long period, and is employing more than 2,500 men.

Iron and Steel Output in April

The British Iron and Steel Federation reports that there were 96 furnaces in blast at the end of April, three furnaces having been blown out for repairs and relining, and one put in operation during the month. The production of pig-iron in April amounted to 526,300 tons, compared with the revised figure of 554,200 tons in March and 496,300 tons in April, 1934. The month's production included 122,700 tons of hematite, 266,900 tons of basic, 120,500 tons of foundry, and 8,300 tons of forge pig-iron. The output of steel ingots and castings amounted to 808,700 tons in April, compared with 841,900 tons in March and 716,800 tons in April, 1934. The comparison with March is affected by the fewer working days in April, due to the shorter month and the Easter holidays.

Contracts Open

Slough, May 27.—3,500 yds. 3-in. and 4-in. cast-iron pipes, for the Urban District Council. The Water Engineer's Office, Council Offices, Slough.

South Africa, June 24.—Four narrow-gauge (2 ft.) locomotives, class NG/G.131 2-6-2 + 2-6-2 type, for the Railways and Harbours Board. The Department of Overseas Trade. (Reference G.Y. 15,118.)

Goldhanger, May 27.—For the Maldon Rural District Council:—(1) Supply of 3 miles 1,089 yds. of 3-in. dia. cast-iron pipes; (2) laying the pipes, etc. Mr. W. Almond, engineer, 6, Market Hill, Maldon, Essex.

Manchester, May 29.—Weldless steel lamp columns and fittings (specification No. 498), for the Electricity Committee. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester, 2.

London, June 4.—The Madras & Southern Mahratta Railway Company, Limited, invites tenders for two locomotive engines and tenders, standard 4-6-2 light (XB) type, broad gauge. The Company's Offices, 25, Buckingham Palace Road, Westminster, London, S.W.1. (Fee £1 1s., non-returnable.)

Lexden, June 4.—For the Lexden and Winstree Rural District Council:—Contract No. (1) Iron-founders. Supply and delivery of approx. 2,800 tons (cast weight), or, alternatively, 2,212 tons (spun weight) of 9-in., 8-in., 6-in., 5-in., 4-in. and 3-in. cast-iron pipes, with approx. 52 tons of special pipe castings. Messrs. Sands & Walker, Milton Chambers, Milton Street, Nottingham. (Fee £5 5s., returnable.)

Stourport, June 4.—Provision, laying and jointing of about six and one-half miles of 7-in., 6-in., 5-in., 4-in. and 3-in. cast-iron water mains, provision and fixing of meter, valves and hydrants, with other works, for the Urban District Council. Messrs. Willcox, Raikes and Marshall, 33, Great Charles Street, Birmingham. (Fee £5 5s., returnable.)

Bombay, June 19.—The Agent, Great Indian Peninsula Railway, Bombay, invites tenders for two locomotive engines and tenders, XP type, broad gauge. The Director-General, India Store Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 10s., non-returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118 Chancery Lane, London, W.C.2.)

F. C. Woodford, Limited, 1, Ashdon Road, Harlesden, London, N.W.—Capital £2,000. Zinc and metal workers. Directors: F. C. Woodford and H. V. Woodford.

C. F. Fieldsend & Company, Limited.—Capital £10,000. Manufacturers of special alloys, manufacturing and general engineers. Directors: A. E. Upton and C. F. Fieldsend.

Company Report

John Brown & Company, Limited.—Profit, including investment receipts, after deduction of all expenses, £228,086; brought in, £18,471; depreciation, £33,948; fees, £3,388; tax, £21,050; interest, £97,812; carried forward, £97,672.

Personal

MR. W. F. HARDSTONE, general manager of the Greenwich Metal Works, owned by Messrs. G. A. Harvey & Company (London), Limited, was unanimously elected a director at the recent general meeting.

ENGINEER REAR-ADMIRAL R. BEEMAN has relinquished his position as Deputy Engineer-in-Chief of the Navy and gone to Barrow-in-Furness as engineering manager of Messrs. Vickers-Armstrongs, Limited. He is succeeded at the Admiralty by Engineer Rear-Admiral G. Preece.

MR. W. J. RICKEY, managing director of the Singer factory, Clydebank, who was seriously injured in a motor-car accident in France while on business for the firm, was to have left this week for America. He was to visit the firm's factory at Brooklyn, U.S.A., to complete negotiations for the transfer to Clydebank of the entire production at Brooklyn.

CERTAIN IMPORTANT managerial changes took effect on Monday, May 20, in the firm of Colvilles, Limited, Motherwell. Mr. John M. Colville, works manager at Dalzell Steel Works, Motherwell, retired. Mr. Colville, who is a son of the late Mr. Archibald Colville, has considerable interests in other concerns, to which in future he is to devote his entire attention. Mr. David G. Fraser, works manager at the Clydebridge Steel Works, Cambuslang, will succeed Mr. Colville at Dalzell Works. Mr. John MacCracken, mill manager at Clydebridge Steel Works, will take over the managership of the works. Mr. David G. Fraser was employed with the old Clydebridge Steel Company, Limited, as chief draughtsman when the works were taken over by Messrs. Colvilles, Limited. Later he became master of works, and when Mr. Percival Smith left for England, became works manager. Mr. MacCracken went to Clydebridge when Colvilles began operations there, and became mill manager, having charge of the modern three-high plate mill, which has achieved world's records in production.

Will

DICKINSON, SIR ARTHUR LOWES, of Haslemere, Surrey, a director of the Ebbw Vale Steel, Iron & Coal Company, Limited, and of other companies ... £21,840

Obituary

MR. JOHN FAIRLAM, formerly manager of Messrs. Walkers, Parker & Company's leadworks at Elswick, died recently, aged 79.

M. PAUL LABBE, the well-known French iron and steel manufacturer, with important blast furnaces at Gorcy, in Eastern France, President of the Aciéres de Longwy, and a director or chairman of several large French iron and steel works, died recently. He was accidentally killed while riding in the Bois de Boulogne, Paris.

WE REGRET TO RECORD the death of Mr. James Duff, manager of the Staveley Coal & Iron Company's sand-spun pipe department. Mr. Duff was taken ill with malaria, septic pneumonia later undermining his constitution, and he failed to rally following a relapse. He was 51 years of age and a native of Dundee. He started his career as an apprentice moulder in the foundry trade, and in 1911 went to India as foundry manager of the Bengal Iron Company, Limited, where he remained for 17 years, gaining a knowledge of the Eastern trade. Returning to England in 1923, he was appointed foundry manager with Messrs. Cochrane & Company, of Dudley, Staffs, in November, 1930, obtaining an appointment with the Staveley Coal & Iron Company, Limited. Mr. Duff was a member of the Institute of British Foundrymen.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

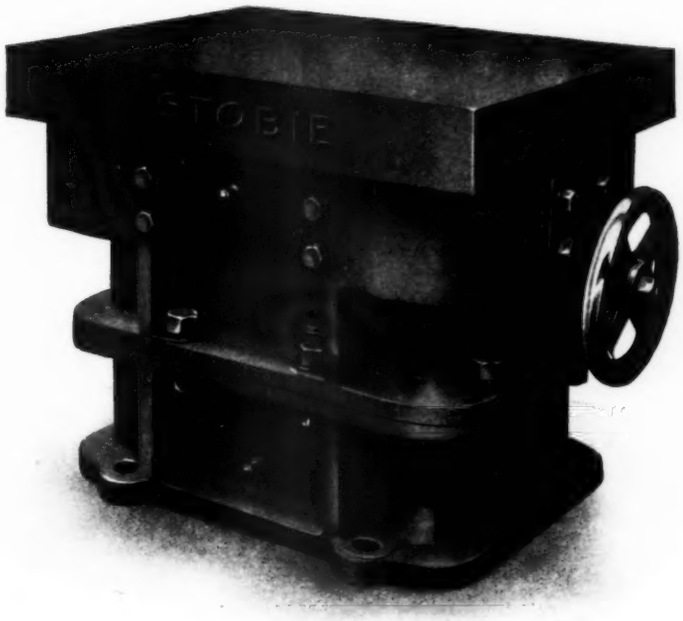
"BICONITE."—Electrodes of ordinary metal for electric welding and liners of ordinary metal for contact blocks of welding plant. British Insulated Cables, Limited, Prescot, Lancashire.

"HESSALITE."—High Speed Steel Alloys, Limited, Ditton Road, Widnes, Lancashire.

XUM

FOUNDRY MOULDING
by
ELECTRICITY

THE STOBIE ELECTRIC JOLT MOULDING MACHINE



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Uses either A.C. or D.C.

SIMPLE to OPERATE

Full particulars apply:

FOUNDRY ENGINEERS LTD.,

HALIFAX, YORKS.

Telephone: 61459 Halifax

Telegrams: "FEL," Halifax

Raw Material Markets

The iron and steel markets generally retain their optimism. Outputs are being maintained at high levels, and the home demand is showing signs of further expansion, although export trading is still strangled by the entanglement of fiscal and financial restrictions on the Continent. Foundry iron is in increasing demand in this country. The seasonal expansion of activity in the building trade is at last beginning to have a beneficial effect on the position of the light-castings manufacturers.

Pig-Iron

MIDDLESBROUGH.—Although the aggregate demand for Cleveland iron is very heavy, the call for foundry numbers alone is still limited, and there are now only two blast furnaces in this district producing merchant iron for the open market. Strong competition is, of course, being experienced from Midland foundry iron. Fortunately, the local steelworks are very big consumers, and the steel furnaces are taking the whole of the output of the 13 blast furnaces producing basic iron. Prices obtainable for export are still unremunerative, but the fixed quotations for home sales are rigid. No. 3 Cleveland G.M.B. being quoted at 67s. 6d. per ton delivered Middlesbrough, No. 1 foundry iron 70s., and No. 4 foundry and No. 4 forge iron 66s. 6d. Delivered prices of No. 3 Cleveland G.M.B. in other areas are:—North-East Coast, 69s. 6d.; Falkirk, 67s. 3d.; and Glasgow, 70s. 3d. per ton.

The East-Coast hematite producers are heavily sold over the next two months, and considerable further business is in sight. Home sales are still predominant, although a few export transactions have been negotiated lately. Home prices are firm and unchanged, quotations for No. 1 East Coast hematite, delivered at consumers' works, being:—Middlesbrough, 69s.; North-East Coast, 71s.; Scotland, 75s.; Lancashire, 76s.; Yorkshire, 75s. to 78s.; Birmingham, 79s. per ton.

LANCASHIRE.—Reports from Midland ironmasters supplying this area indicate that the total volume of foundry-iron consumption is well maintained, with indications of expansion in one or two trades. Many speciality foundries are busily engaged, and the machine-tool and heavy electrical branches are taking satisfactory tonnages. Current offers of Staffordshire, Derbyshire and Lancashire brands of No. 3 for delivery to works in the Lancashire zone are maintained on the basis of 74s. per ton, with Northamptonshire iron at 72s. 6d., Derbyshire forge at 69s. to approved consumers, Scottish at up to 82s. 6d., West Coast hematite at around 78s. 6d., and East Coast material at from 75s. to 76s., according to grade.

MIDLANDS.—A feature of the foundry-iron trade in this area is the slightly better demand for iron from the light-castings manufacturers. Although the work is unevenly spread, in the aggregate there has been an improvement, and it is thought that May will prove to be the best month experienced so far this year. The controlled rates delivered Birmingham and Black Country stations are 67s. 6d. per ton for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3. Under certain conditions large consumers of these irons can claim a graduated rebate. The demand for foundry iron of special analysis, used chiefly by the engineering and jobbing trades, is satisfactory and there is a gradual improvement. Some of the works, in fact, are now better situated for business than they have been for a considerable time. There is no control on this type of iron, which comes from various parts of the country. Medium-phosphorus grades are offered at from 72s. to 80s. and low-phosphorus, including Scottish No. 3, at from 85s. to 90s. Where special refined pig-iron is wanted to close analysis limits the prices range from £5 7s. 6d. to £7 per ton delivered this district.

SCOTLAND.—Rather more activity has been witnessed on the Glasgow pig-iron market lately, although foundry-iron is still relatively the quietest section. Quotations are unaltered at 70s. f.o.t. furnaces for No. 3, with 2s. 6d. per ton extra for No. 1. English irons are in good demand in the light-castings trade, which is very active just now. No. 3 Cleveland is 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t Glasgow, other English foundry irons being 1s. 3d. per ton below these figures.

Coke

Cupola coke is a rather sluggish market at the present time, consumers tending to delay the fixing of fresh contracts in the hope that there will be a fall in prices during the summer months. Current quotations for delivery in the Birmingham area are unchanged at:—Best Durham coke, 36s. to 40s.; Welsh coke, 34s. to 43s. 6d. per ton.

Steel

The active conditions which recently developed in the steel markets have been well maintained, and most branches of the industry have benefited. This is partly due to the absence of competition from imported steel, as practically no Continental material has been offered in the British market for some weeks. Business in this class of steel has been confined almost entirely to merchants holding old contracts. In the semi-finished steel department, the demand has been rather limited. Most of the consuming works are carrying large stocks, and there is little inducement to enter into forward commitments. Deliveries against specifications, however, are on a heavy scale. Most branches of the finished-steel department are well employed, and new business is coming forward more freely than of late. The home market is providing a good outlet, and the export trade is slowly improving.

Scrap

Scrap iron remains generally in good demand. In the Cleveland area, heavy cast iron has become rather scarce, but is still quoted at 52s. 6d. to 53s. per ton, while machinery metal, broken to handy sizes, has realised 55s. The position is unchanged in the Midlands, heavy machinery metal in handy sizes being 55s. to 57s. 6d., good heavy pipe and plate scrap 50s., and clean light cast iron 47s. 6d., all delivered works. In South Wales there is a rather better inquiry for heavy cast iron, which is slightly firmer at 52s. to 53s., but good cast-iron machinery scrap is only being disposed off in odd lots at 52s. 6d. to 55s. Good, clean, heavy machinery cast-iron scrap is firmly quoted in Scotland at 56s. 6d., with ordinary cast-iron scrap to the same specification 52s. 6d.

Metals

Copper.—The London copper market has maintained its firm tone. So far, there is no sign of quotations suffering a serious setback, although in some quarters the recent rise is ascribed solely to artificial conditions, particularly to speculative buying on the Continent owing to the fear of currency devaluation.

Messrs. Rudolf Wolff report that:—"The turnovers for standard have been exceedingly large, but the heavy sales on our market have been readily absorbed, and there seem to be a considerable number of new buying interests, which makes the position technically sounder. It is reported that the Roan Antelope Copper Mines, Limited, state officially that they recently agreed to restrict output, provided that the plan of restriction is strictly adhered to. It certainly looks as if copper should move to higher levels, as there is quite a good consumptive demand, and consumers are, if anything, understocked."

Daily market prices:—

Cash.—Thursday, £33 15s. to £33 17s. 6d.; Friday, £33 18s. 9d. to £34; Monday, £33 18s. 9d. to £34; Tuesday, £33 12s. 6d. to £33 15s.; Wednesday, £33 18s. 9d. to £34.

Three Months.—Thursday, £34 3s. 9d. to £34 5s., Friday, £34 7s. 6d. to £34 8s. 9d.; Monday, £34 7s. 6d. to £34 10s.; Tuesday, £34 to £34 2s. 6d.; Wednesday, £34 6s. 3d. to £34 7s. 6d.

Tin.—Prices remain very firm, owing to the comparative scarcity of spot supplies, which continue to command a heavy premium over three months' metal, this being, of course, a reversal of the usual position.

The situation continues to excite much adverse comment on the London Metal Exchange, and the control authorities are criticised for not releasing more metal. Messrs. Brandeis, Goldschmidt, for instance, say in their weekly report:—"The situation of this metal on the London market is getting worse, and must have a very harmful effect on the consumption of tin. One cannot expect consumers to be very anxious to increase their turnover in a metal in which it is impossible to hedge against purchases of the raw material."

Day-to-day fluctuations:—

Cash.—Thursday, £227 15s. to £228; Friday, £229 10s. to £229 15s.; Monday, £228 10s. to £229; Tuesday, £228 10s. to £228 15s.; Wednesday, £229 5s. to £229 15s.

Three Months.—Thursday, £220 15s. to £221; Friday, £222 10s. to £223; Monday, £221 7s. 6d. to £221 12s. 6d.; Tuesday, £221 15s. to £222; Wednesday, £222 12s. 6d. to £222 17s. 6d.

Spelter.—On Friday the price of spelter reached the highest level of the year. There has been a heavy demand for supplies both in this country and on the Continent. It is stated that considerable progress has been made in the negotiations between representatives of producers, consumers and the London Metal Exchange on the question of the new duty proposals.

Official quotations were as follow:—

Ordinary.—Thursday, £14 13s. 9d.; Friday, £15; Monday, £14 15s.; Tuesday, £14 12s. 6d.; Wednesday, £14 16s. 3d.

Lead.—Strengthened by the heavy demand from building-accessories manufacturers, lead has remained a firm market. Apart from the good industrial demand, there has been a considerable demand for lead on the Continent for investment purposes.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £14; Friday, £14 2s. 6d.; Monday, £14 3s. 9d.; Tuesday, £14 2s. 6d.; Wednesday, £14 8s. 9d.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

424,336. VEREINIGTE STAHLWERKE AKT.-GES. Method of producing iron sleepers.
424,359. FELL, H. V. Casting of shaped-metal sections.
424,373. RYLANDS BROS., LIMITED, and RYLANDS, G. K. Methods and apparatus for galvanising or zinc-coating iron or steel articles.
424,463. HAYNES STELLITE COMPANY. Alloys.
424,656. BENNIE, H. O., and ORR, R. W. Machines and appliances for shearing metal plates and the like.
424,663. SACHTLEBEN AKT.-GES. FÜR BERGBAU UND CHEMISCHE INDUSTRIE. Process of and apparatus for the production of molten iron or steel by the direct method.
424,762. HEIDE, H. C. (Stargardter, A.R.). Heat-treatment of metal strip.
424,781. VEREINIGTE STAHLWERKE AKT.-GES. Corrosion-resisting steel and iron alloys.
424,816. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Resistance welding or heating electrodes.
424,861. TRIPP, J. P. Arc-welding apparatus.
424,865. BIGELOW, F. B. Furnace walls.
424,873. SCHLOEMANN AKT.-GES. Tilters for rolling mills.
426,633. GRIFFITHS, H. A. Presses for cutting metal and other sheets.
426,506. BÖHLER & COMPANY AKT.-GES., GEB. Hard-metal alloys.
426,374. ERICSSON, N. O. J. Channel-formed repeaters for rolling mills.
426,868. SCHREIBER, F. Baths for molten metal.
426,728. MUELLER, W. Mechanical furnace for roasting sulphurous ores.
426,765. HAGLUND, T. R. Refining of alloys.
426,768. KRUPP GRUSONWERK AKT.-GES., F. Cold-rolling of metal sheets, strips, and the like.
426,770. ARNOLD, C. (Cleveland Graphite Bronze Company). Method of and apparatus for making composite metal strip.

XUM

Sterling

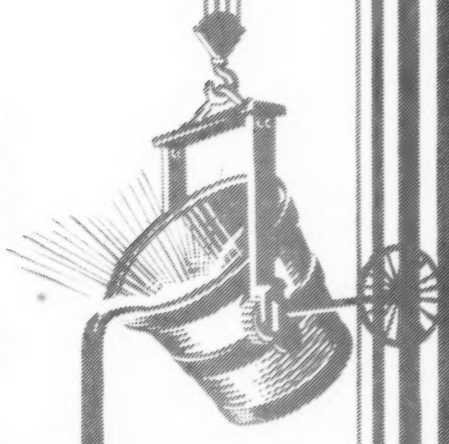
MOULDING BOXES

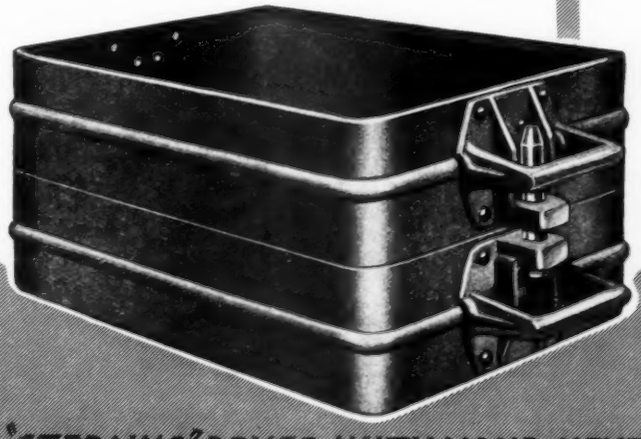
... are designed for the modern foundry

One of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX . . . the result is speed and economy all round. Your moulders will put down more moulds per day because of the light and easy handling properties of these boxes.

You will be sure of producing accurate castings because STERLING BOXES maintain their accuracy permanently.

Sterling Boxes—Save their cost in a few months, and are obviously a sound investment for any foundry.





SPECIFY "STERLING" BOXES WITH YOUR NEXT ORDER

STERLING FOUNDRY SPECIALTIES LTD

STERLING WORKS **BEDFORD**

LONDON OFFICE: 13 VICTORIA STREET, WESTMINSTER, S.W.1.

RAW MATERIALS—PRICE LIST

(Wednesday, May 22, 1935)

COPPER

	£ s. d.
Standard cash	33 18 9
Three months	34 6 3
Electrolytic	37 0 0
Tough	35 15 0
Best selected	36 5 0
Sheets	64 0 0
India	47 15 0
Wire bars	37 15 0
Ingot bars	37 15 0
H.C. wire rods	41 5 0
Off. av. cash, April	31 5 4⅞
Do., 3 mths., April	31 13 9
Do., Sttlmnt., April	31 5 3
Do., Electro, April	35 1 10½
Do., B.S., April	34 13 0⅝
Do., wire bars, April	35 8 6
Solid drawn tubes	10d.
Brazed tubes	10d.
Wire	6½d.

BRASS

Solid drawn tubes	9½d
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7¾d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	229 5 0
Three months	222 12 6
English	229 15 0
Bars	231 12 6
Straits (nom.)	240 5 0
Australian (nom.)	—
Eastern	231 10 0
Banca	237 10 0
Off. av. cash, April	223 13 8¼
Do., 3 mths., April	219 18 0¾
Do., Sttlmt., April	223 13 9

SPELTER

	£ s. d.
Ordinary	14 16 3
Remelted	14 10 0
Hard	11 15 0
Electro 99.9	17 8 9
English	15 17 6
India	13 10 0
Zinc dust	17 10 0
Zinc ashes	3 5 0
Off. aver., April	13 0 2¼
Aver. spot, April	12 17 9¾

LEAD

	£ s. d.
Soft foreign ppt.	14 8 9
Empire (nom.)	15 11 3
English	16 10 0
Off. average, April	12 6 10⅞
Average spot, April	12 4 7½

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 10 0
Do., V.M. ex-whse.	24 12 6
Rods	28 15 0

ANTIMONY

	£ s. d. to £ s. d.
English	76 0 0 to 77 0 0
Chinese, ex-whse., (nom.)	64 0 0
Crude	—

QUICKSILVER

	£ s. d. to £ s. d.
Quicksilver	11 5 0 to 11 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	31 10 0
4/6% car.	21 15 0
6/8% car.	21 10 0
8/10% car.	21 10 0
Ferro-chrome—	
Max. 2% car.	34 0 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/- to 5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d
Finished bars, 18% tungsten	2s. 9d

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 15 0	to 2 16 0
Bundled shrngs.		2 7 6
Mixed iron and steel	2 10 0	to 2 12 0
Heavy cast iron	2 11 0	to 2 13 0
Good machinery	2 12 6	to 2 15 0
Cleveland—		
Heavy steel		2 12 6
Steel turnings		1 15 0
Cast-iron borings		1 5 0
Heavy cast iron	2 12 6	to 2 13 0
Heavy machinery		2 15 0
Midlands—		
Light cast-iron scrap		2 7 6
Heavy wrought iron	2 17 6	to 3 0 0
Steel turnings, f.o.r.		1 14 0
Scotland—		
Heavy steel		2 10 0
Ordinary cast iron		2 12 6
Engineers' turnings		1 19 6
Cast-iron borings	1 17 6	to 1 19 0
Wr'ght-iron piling	2 16 6	to 2 18 6
Heavy machinery		2 16 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	27 0 0
Brass	18 0 0
Lead (less usual draft)	13 0 0
Tea lead	9 10 0
Zinc	9 0 0
New aluminium cuttings	66 0 0
Braziery copper	23 0 0
Gunmetal	25 0 0
Hollow pewter	155 0 0
Shaped black pewter	110 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 10 0	to 8 0 0
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	14 2 6	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ⅝ in. (Untested)		8 12 0
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)		9 7 0
Black sheets, 24g. (4-t. lots)		10 10 0
Galv. cor. shts. (,,)		13 0 0
Galv. flat shts. (,,)		13 10 0
Galv. fencing wire, 8g. plain		14 10 0
Billets, soft	5 10 0	and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 2 6	to 5 10 0
Tin bars	5 2 6	to 5 7 6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10d.
Sheet to 10 w.g.	11½d.
Wire	12d.
Rods	10½d.
Tubes	13½d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.8832
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	19/- to 22/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 to 19/2
,,	28×20 ,,	36/4 to 38/4
,,	20×10 ,,	26/- to 26/3
,,	18⅞×14 ,,	18/6 to 18/9
C.W.	20×14 ,,	15/3 to 16/3
,,	28×20 ,,	32/9 to 33/3
,,	20×10 ,,	22/9 to 23/9
,,	18⅞×14 ,,	15/9 to 16/9

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
May 16 ..	33	15	0	inc.	6/3
„ 17 ..	33	18	9	„	3/9
„ 20 ..	33	18	9	No	change
„ 21 ..	33	12	6	dec.	6/3
„ 22 ..	33	18	9	inc.	6/3

Electrolytic Copper

	£	s.	d.		
May 16 ..	37	0	0	No	change
„ 17 ..	37	5	0	inc.	5/-
„ 20 ..	37	0	0	dec.	5/-
„ 21 ..	37	0	0	No	change
„ 22 ..	37	0	0	„	„

Standard Tin (cash)

	£	s.	d.		
May 16 ..	227	15	0	inc.	20/-
„ 17 ..	229	10	0	„	35/-
„ 20 ..	228	10	0	dec.	20/-
„ 21 ..	228	10	0	No	change
„ 22 ..	229	5	0	inc.	15/-

Tin (English ingots)

	£	s.	d.		
May 16 ..	228	5	0	inc.	20/-
„ 17 ..	229	15	0	„	30/-
„ 20 ..	229	5	0	dec.	10/-
„ 21 ..	229	0	0	„	5/-
„ 22 ..	229	15	0	inc.	15/-

Spelter (ordinary)

	£	s.	d.		
May 16 ..	14	13	9	dec.	1/3
„ 17 ..	15	0	0	inc.	6/3
„ 20 ..	14	15	0	dec.	5/-
„ 21 ..	14	12	6	„	2/6
„ 22 ..	14	16	3	inc.	3/9

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
May 16 ..	17	6	3	No	change
„ 17 ..	17	10	0	inc.	3/9
„ 20 ..	17	6	3	dec.	3/9
„ 21 ..	17	5	0	„	1/3
„ 22 ..	17	8	9	inc.	3/9

Zinc Sheets (English)

	£	s.	d.		
May 16 ..	24	0	0	No	change
„ 17 ..	24	10	0	inc.	10/-
„ 20 ..	24	10	0	No	change
„ 21 ..	24	10	0	„	„
„ 22 ..	24	10	0	„	„

Lead (English)

	£	s.	d.		
May 16 ..	16	0	0	No	change
„ 17 ..	16	0	0	„	„
„ 20 ..	16	5	0	inc.	5/-
„ 21 ..	16	5	0	No	change
„ 22 ..	16	10	0	inc.	5/-

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in April and the four months, 1935, compared with a year ago.

	April.		Four months.		April.		Four months.	
	1934.	1935.	1934.	1935.	1934.	1935.	1934.	1935.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	9,333	2,978	32,514	27,234	25,786	8,706	89,032	79,253
„ Foreign Countries	1,069	1,172	5,414	4,541	5,842	7,090	31,453	26,724
Total	10,402	4,150	37,928	31,775	31,628	15,796	120,485	105,977
Castings and forgings	496	433	1,025	1,078	10,663	9,474	24,431	28,161
Cast pipes and fittings	81	54	475	250	4,153	1,757	26,393	11,039
Stoves, grates, etc.	76	116	272	354	7,667	10,524	26,886	32,310
Baths	776	510	2,731	2,068	18,161	13,474	64,746	56,635
Hollow-ware, all kinds	192	249	806	818	12,134	16,586	44,242	52,827
Exports.								
Pig-iron, forge	113	288	362	582	472	1,128	1,490	2,464
„ foundry	6,781	11,094	22,490	29,120	20,625	38,421	75,354	99,933
„ acid	6,877	7,213	15,601	16,329	22,018	22,928	49,347	52,066
„ basic	100	1	665	204	326	5	2,146	604
Total	13,871	18,596	39,118	46,235	43,441	62,482	128,337	155,067
Castings and forgings	645	351	1,719	1,422	20,975	13,516	63,881	53,204
Cast pipes and fittings, up to 6 in. diameter	6,399	3,865	19,455	17,679	65,049	43,726	215,544	195,032
„ „ „ over 6 in. „	3,769	2,938	14,657	12,849	28,033	22,010	107,649	101,179
Stoves, grates, etc.	696	554	2,806	2,568	31,121	30,624	133,160	129,726
Sanitary cisterns	226	174	940	1,023	6,834	5,369	27,274	28,551
Bedsteads, inc. tubes therefor	442	353	1,751	1,446	14,883	13,228	57,884	54,249
Cast hollow-ware	281	370	1,139	1,314	10,299	14,441	42,331	50,666

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOREMAN or Assistant Foreman. Position required. Experienced general engineering castings up to 30 tons. British and American experience. Technically trained.—Box 250, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

IRONFOUNDRY Foreman working in Lancashire town seeks position with progressive firm; 36 years' experience in modern foundry practice.—Box 248, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WORKS MANAGER having full control wanted for modern engineering works 70 miles from London. Must be fully conversant with modern practice and used to handling mass products of highest quality. Good knowledge of foundry practice essential. Applications by letter, giving full details of education, experience, age and salary required will be treated in strict confidence.—Box 256, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

NOTICE

1935 G. 011.

In the High Court of Justice,
Chancery Division.

MR. JUSTICE FARWELL.

IN THE MATTER OF THE GLOUCESTER FOUNDRY, LIMITED.

and

IN THE MATTER OF THE COMPANIES ACT, 1929.

NOTICE is hereby given that a Petition presented to the High Court of Justice, Chancery Division, on the 18th day of April, 1935, for confirming the reduction of the Capital of the above named Company from £45,000 to £32,500 by cancelling capital which has been lost or is unrepresented by available assets is directed to be heard before Mr. Justice Luxmoore on Tuesday the 4th day of June, 1935. Any Creditor desiring to oppose the making of an order for the reduction of the Capital of the said Company under the above Act may appear at the time of hearing by himself or his Counsel for that purpose. Such person is required to give two clear days' notice in writing of his intention to appear with the grounds of his objections to the undersigned, the London Agents for the Solicitors of the Company. A copy of the Petition will be furnished to any person requiring the same by the undersigned on payment of the regulated charge for the same.

Dated the 17th day of May, 1935.

WILLIS & WILLIS,
59, Chancery Lane,
London, W.C.2.

Agents for
Taynton & Son,
Gloucester,
Solicitors for the Company.

MACHINERY

TILGHMAN SAND BLAST ROOM for sale. 12 ft. by 9 ft., standard-type plant, practically new, owing to centralisation. This plant can be seen erected and will be sold reasonably owing to the closing of a large works, in London.—Box 252, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY—*Continued*

MORGAN TILTING FURNACES for sale: sizes 400, 600 and 800 lbs. capacity; several in stock, oil-fired, also coke-fired. Please state requirements. Cheap prices: immediate delivery; relined ready for use.—ALEX. HAMMOND, 14, Australia Road, Slough.

SAND MIXERS AND MILLS for sale, several well-known makes in stock. Write stating requirements.—Box 260, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND PLANT.

ROTOIL No. 4 oilsand mixer. Ketin & Thiviart three-in-one motor-driven sand-mill, mixer and whizzer. Pneulec large oilsand mixer. Several pneumatic sand sifters.—ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

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Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

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Most of the above by Tilghman and complete with Air Compressors.

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MISCELLANEOUS—*Continued*

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18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.

SANDBLAST PLANTS

8'×8'×8' Tilghman room plant with 300 cu. ft. Tilghman compressor dry air filter and all equipment, practically new plant throughout.
12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories. FINE PLANT.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel 30"×20".

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

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